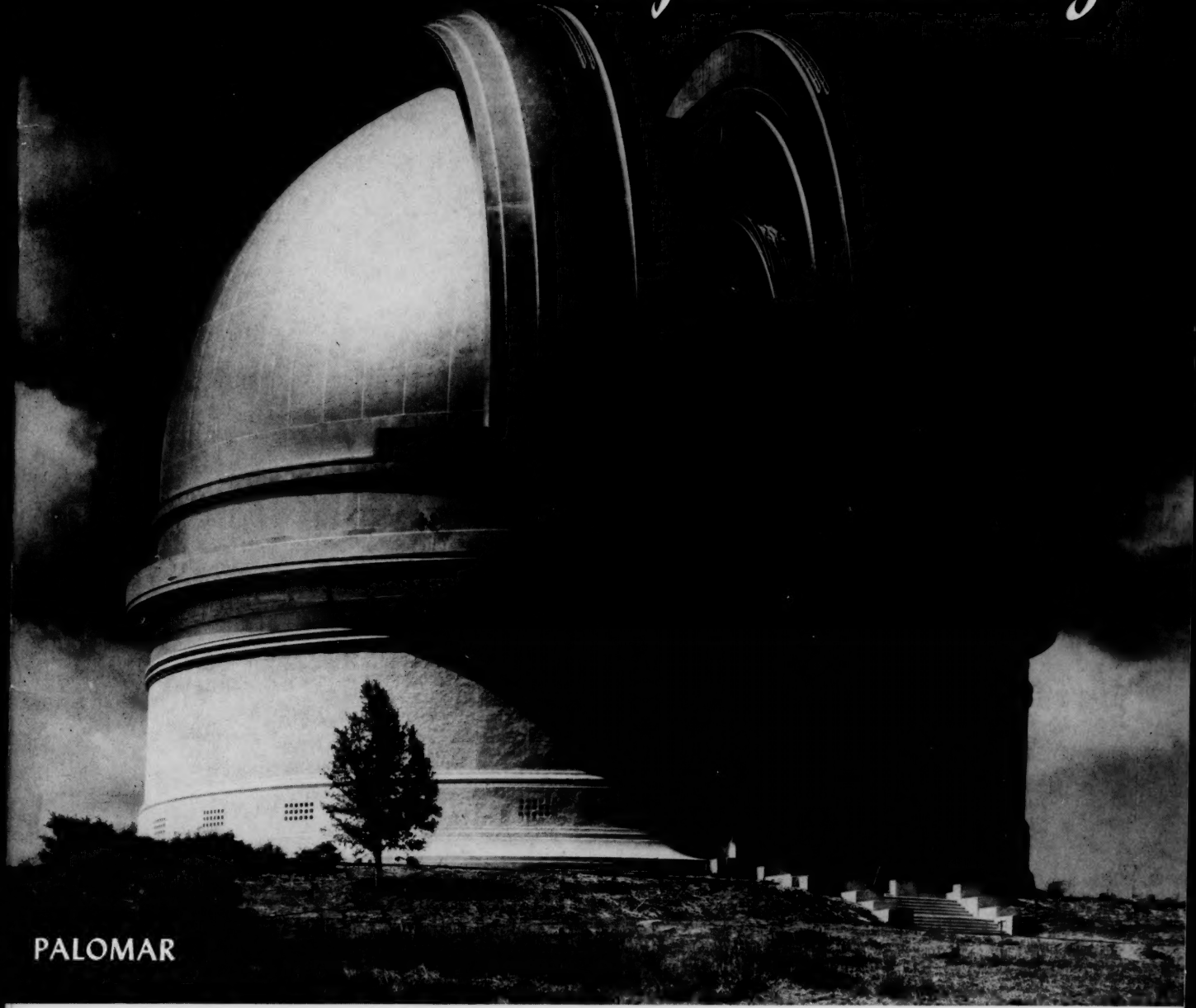
Pacific Discovery



PALOMAR

PUBLISHED BI-MONTHLY BY THE CALIFORNIA ACADEMY OF SCIENCES

IN THIS ISSUE: *Woodbridge Metcalf* • *Philip Ferry*
Gayle Pickwell • *Earle G. Linsley* • *A. Starker Leopold*
Walter C. Lowdermilk • *J. Wyatt Durham*

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Pre-Discovery:

Cannibals who exquisitely decorated their houses and played a skillful game of chess!—such were the Bataks of interior Sumatra until a generation or two ago. The illustrations of "Sumatra's Minangkabaus and Bataks" show no boiling cauldrons, but display the rich architecture of a settled Oriental culture. ¶Coming down out of "The Haunted Canyon" in northern California hills, Ishi, last of his tribe, not only gave himself up, well within this century, to the white destroyers of his people, but—it seemed willingly—became a prize "laboratory specimen" of the University of California's Museum of Anthropology, and a noted physician's instructor in archery. His story will be retold from the scientific reports.

Publication of the article on volcanoes, announced in "Pre-Discovery" for March-April, has been indefinitely postponed.

Discovering PD's Authors:

To find Professor **Woodbridge Metcalf,** Extension Forester at the University of California College of Agriculture, one should take to the woods. He may be caught, now and then, at his desk on the Berkeley campus, but generally he is in the field, teaching the wise and scientific use of our forest resources, or observing and recording the "Youthful Years of the Big Tree" on his plots in Whitaker's Forest.

Talking with **Philip Ferry** recently, we did not learn much about the author of "Marble Falls of Havasu" except that he is a San Franciscan, member of the Academy and the Sierra Club, and has an itchy foot, but we did discover a fellow-enthusiast for the Southwest who likes unbeaten tracks.

Dr. **Gayle Pickwell,** Professor of Zoölogy, San Jose State College, hardly needs introduction to students of Western nature. Most of them know his books on animals, birds, deserts, weather, and his newest title, *Amphibians and Reptiles of the Pacific States* (Stanford University Press, 1947). His readers delight not only in his lucid style but also in the profuse illustrations which have made him known as one of the West's leading nature photographers. He contributed richly to our last issue, and "Clouds and Weather" in this is essentially a picture story.

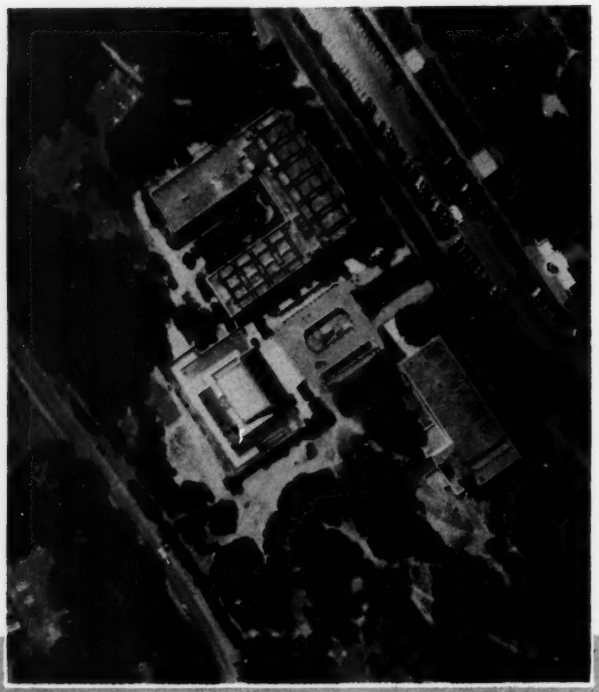
Mention of Dr. **Earle G. Linsley's** "Discovery in Space"—story of the 200-inch reflector of Mt. Palomar—must include grateful acknowledgment to Edison R. Hoge, official photographer of the Mt. Wilson Observatory, and to the Observatory Council, for their generous contribution of our cover and two text pictures.

America is all too slowly waking up to one of the most serious threats to its national health, recreation, and economy—waking up to the alarming sight of once-clear rivers clogged with silt and poisoned with wastes, of sea beaches near cities fouled with garbage, and the waters of bays and the ocean itself made unsafe for bathing by raw sewage. Dr. **A. Starker Leopold,** our Conservation Editor, gives us warning in "Clear Water."

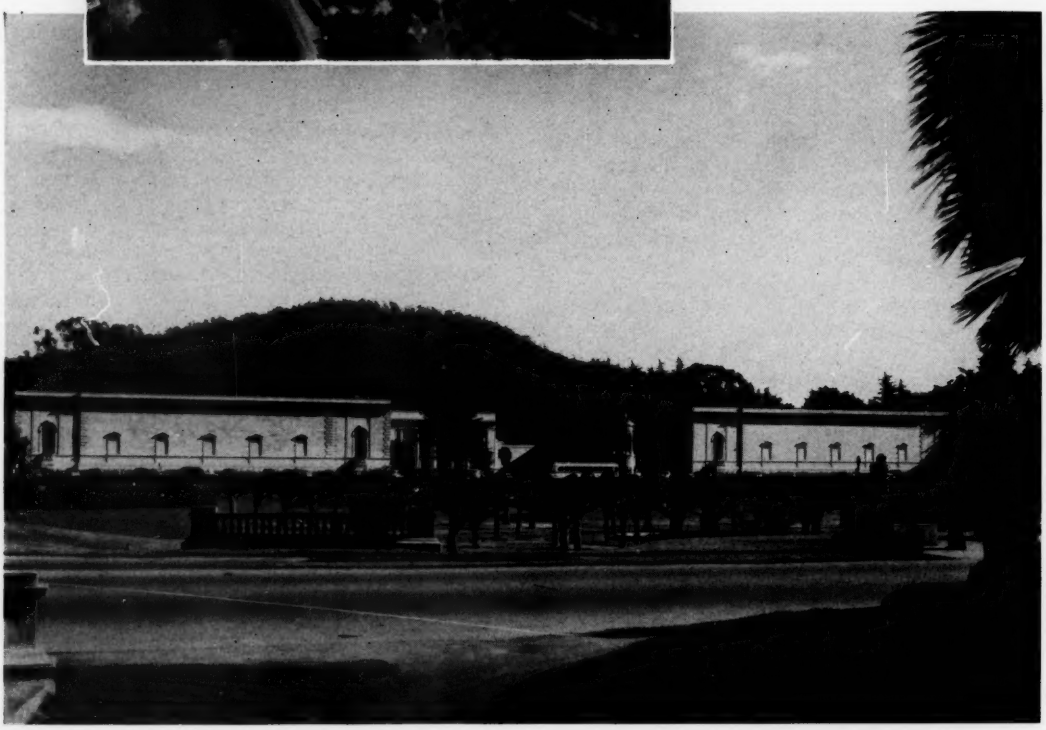
The world is all too slowly waking up to the greatest of threats to the future of the human race—not the atom bomb, Damocles' sword though that is, but—starvation. We breed faster than ever, we lengthen our life span through applied science—and we destroy the land which feeds us. Dr. **Walter C. Lowdermilk** (see editorial note heading "The Eleventh Commandment") is not another "prophet of doom," but a responsible public official, an acknowledged expert in the causes of soil erosion and the technology of land conservation.

The earth is forever burying its past under layers of rock and silt, and scientists like **J. Wyatt Durham,** Associate Professor of Paleontology at the University of California, persistently dig and hammer away to uncover the fragmentary records of ancient life, such as "Fossil Starfish." Dr. Durham has hunted fossils from Java and Sumatra to Colombia and California.

D. G. K.



California Academy of Sciences Buildings in Golden Gate Park, San Francisco (aërial view). Upper: North American Hall. Dark roof within the U is shed covering skeleton of sulphur-bottom whale. Lower right: Simson African Hall. Left: Steinhart Aquarium. Center: sea lion pool. Space between Aquarium and African Hall is site of Planetarium and other new buildings soon to be started.



Academy Buildings—view across the Music Concourse, Mt. Sutro in the background. Left: Simson African Hall, with dioramas of African mammals; department of Exhibits; departments of Insects, Fishes; Junior Science Group clubroom; Academy executive and administrative offices; Publications. Center back: Steinhart Aquarium, with department of Aquatic Biology. Right: North American Hall, with dioramas of North American mammals and birds; botanical, mineralogical and other exhibits; departments of Botany, Birds and Mammals, Paleontology, Reptiles and Amphibians; Library; cabinet, optical, and instrument shops. (Photograph by Lionel T. Berryhill)

EDITORIAL: *YOUR ACADEMY*

FIVE YEARS HENCE the California Academy of Sciences will celebrate its first centennial, for it was founded ninety-five years ago on April 4, 1853. This is a respectable age for an institution in any land, and might appear venerable on our comparatively young Pacific Coast. But with all its years your Academy today is not only vigorous but is enjoying one of its greatest periods of expansion.

Since the turn of the year the Academy has more hundreds of subscribers to *Pacific Discovery*. Perhaps there is due them a brief review of the institution's origin, history, and aims.

Even in the rude Gold Rush days of 1853 there were, among San Francisco's 50,000, seven men of sufficient intellectual and scientific curiosity to meet together and form "The California Academy of Natural Sciences" (shortened to "California Academy of Sciences" in 1868)—an association whose "objects shall be the investigation and development of Natural Science, the collection of a cabinet of specimens and a Library to embrace the standard and current works on Natural History and Natural Science . . ." Others soon joined the founding group, the constitution providing that "Scientific gentlemen may be received as resident members." Nor were women excluded. In the fall of 1853 it was "resolved, as the sense of this Society, that we highly approve of the aid of females in every department of natural history, and we earnestly invite their cooperation."

The first regular meetings were held at what is now 622 Clay Street in the office of Colonel Thomas B. Nevins, San Francisco's first Superintendent of Schools; and as specimens and books were donated Colonel Nevins' rooms became the first museum and science library in the West.

From these small but energetic and ambitious beginnings the Academy grew, sometimes slowly, at other times rapidly through generous aid. The biggest lift came in the 'nineties when the Academy became residuary legatee of half the estate of the great philanthropist James Lick, and built on a Market Street lot, deeded by Mr. Lick in 1875, one of the finest museum buildings in America. The Academy became a full fledged scientific institution with exhibits open to the public, a staff of curators engaged in research, and a steady stream of scientific papers coming from its press.

But building and contents, including a priceless scientific library, were lost in the great fire of April 1906. Saved only were some books and type specimens which Miss Alice Eastwood, then as now Curator of Botany, rescued at the cost of her own personal belongings.

Just ten years later, from a fresh start, the Academy opened its first museum building on its present site in Golden Gate Park, North American Hall. In 1923 the Steinhart Aquarium was added, and in 1936 the first unit of Simson African Hall—one of the world's finest halls of modern habitat groups.

Today, within these three buildings, the Director and his staff carry on a program broadly twofold: its aims—to gain knowledge of the natural world, and to present this knowledge to the public for education and enjoyment. The seven scientific departments are constantly engaged in research and in the care and enlargement of the collections. Staff members have spent months, even years in the field, collecting and observing both near home and in distant parts of the world. Results of scientific research are recorded and published in the *Proceedings* and the *Occasional Papers*, totaling, since the first *Proceedings* in 1854, many thousands of pages. Some of the collections are among the nation's foremost. The Academy Library contains 100,000 scientific works and 60,000 maps.

The displays—prepared by the department of exhibits and the shops—are open free to the public seven days a week. Free to everyone, also, are the regular monthly meetings with illustrated lectures on a wide variety of nature and science subjects. Then there is the growing and important Junior Science Group devoted to guiding and encouraging youthful naturalists.

Our future, we hope, will "copy fair the past." Funds have been donated and are still being subscribed by generous friends for a truly impressive expansion of the Academy's plant and activities. Work will be started in the not distant future on an addition to the Simson African Hall; a modern auditorium—gift of the late Mrs. Alexander F. Morrison; a Hall of Man and Nature—a gift in memory of the late Lovell T. White; and, perhaps most interesting of all, a planetarium.

Beginning as a kind of club of eager amateur scientists, the Academy has since attained a much more public character, with emphasis more and more on public education. Such institutions fill a special niche, meet a particular need in the cultural life of their respective communities and of the whole nation. And in a larger sense they, like science itself, are international; they are part of the very civilization mankind has so painfully built and is now struggling desperately to keep alive and growing. This Academy is growing, not to become merely bigger, but to give more of its particular store of the things of culture, of knowledge of nature and the universe, to ever more people.

The officers and staff of your Academy greet all its new members. Come out to Golden Gate Park and visit us.

M. E. LOMBARDI, *President*

WOODBRIDGE METCALF

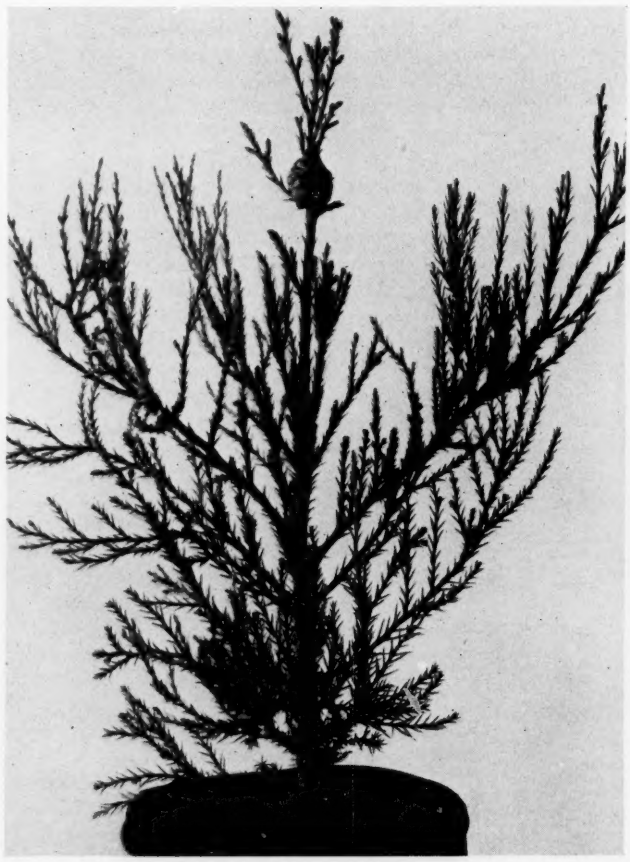
Youthful Years of the BIG TREE

MUCH HAS BEEN WRITTEN about the veteran Big Trees of the Californian Sierra Nevada. Their massive size, great age, and stately grandeur have been extolled in poetry and prose, so that they are perhaps better known throughout the world than any other American tree. It is doubtless quite natural that much attention has been paid to these giants of the forest—virtually none to lesser individuals of the species, middle-aged and youthful Sequoias. Moreover, many people appear to believe that these great old trees are the last survivors of a vanishing race, that they are no longer able to reproduce their kind, and that when they die the world will know them no more. Happily these beliefs are not true; but, because so widely held, they must represent questions in men's minds. If there are young Sequoias today—giants of a distant future—what is their history, from seed to seedling, to sapling, to mature tree? How do they grow? Under what conditions? Are they strong or weak, many or few? What, in a word, are the chances for the species' survival, here in these few scattered groves on the west slope of the Sierra which together make *Sequoia gigantea's* last stand on earth?

Once the Big Tree's immediate future was secured, the giants saved from the ax by the creation of national parks and forests, answers to the questions of long-term survival were to be sought in knowledge gained through careful, detailed study of the entire life cycle of Sequoia, particularly of the critical early stages.

Modern scientific forestry supplied the techniques of study; the University of California, through the generosity of Horace Whitaker, furnished the "laboratory." Whitaker's Forest, 320 acres, 5500 to 6500 feet elevation, stands in the optimum region for *Sequoia gigantea,* on the slopes of Redwood Mountain in Tulare County. When he gave the tract to the University of California in 1910, Horace Whitaker specified in his deed of gift that it be used "for study and teaching of forestry and the enjoyment of the people."

Logging the area during the period from 1870 to 1876, mostly for sugar pine, opened up the timber stand, and evidently created ideal conditions for forest reproduction. Though several old Sequoias were cut at that time, some two hundred veteran Big Trees remained, together with adequate seed trees of sugar pine, ponderosa (western yellow) pine, white fir, and incense cedar. Weather conditions between 1878 and about 1882 must have been exceedingly favorable, resulting in a dense seedling stand of all these species throughout the entire area. Five sample plots for study of growth and mortality were established in these young stands by the writer in the summer of 1915. All trees were tagged and measured at that time and have since been remeasured at



LEFT: *Three - year - old Sequoia seedling, showing the foliage typical of very young trees and new growth of older trees. This nursery-grown baby has produced a cone, of nearly normal size—although seed production usually begins when the Sequoia is 40 or 50 years old. (Photograph by W. C. Matthews)*

RIGHT: *A Sequoia veteran of Whitaker's Forest. Conical crown and rounded masses of dense foliage, average diameter of 10 to 12 feet, and average height of 225 to 250 feet, indicate that this and similar vigorous individuals have reached a mature middle age, 1000 to 1200 years. Young Big Trees in the background show the typical slender, feathery crowns of 60- to 70-year-old second growth. (Photograph by Woodbridge Marshall)*

West slope of Redwood Mountain from the clearing at Whitaker's Forest, 1926. The skyline shows the rounded crowns of old Sequoias. In the foreground, the tall, slender cones of 50-year second growth mingle with associated ponderosa and sugar pines, incense cedars, and white firs. (Photograph by the author)

about five year intervals. A sixth plot was marked off in 1940.

Periodically, Sequoia cones have been collected from which seed has been extracted and studied in the greenhouse and nursery at Berkeley by several members of the Forestry staff, including Professor F. S. Baker and Dr. N. T. Mirov. Sequoia seedlings have been grown in the nursery and many returned to the plantation at Whitaker's Forest, where under favorable conditions they are making extremely rapid and satisfactory growth. These studies, together with observations at other points, are the basis for what will be said here on the reproduction and growth of these remarkable trees.

The Sequoia's Seed

For such huge trees, Big Tree seeds are almost inconceivably small. The seed is like a tiny, golden brown wafer, or bit of sawdust, which will lie on the ground unnoticed by most people who pass through the woods. It takes from 80,000 to more than 100,000—about 90,000 at an average—of these tiny bits of life to make a pound.

The cones which produce the seeds need two growing seasons to mature. They are light green, oval, about two inches long by one inch in diameter, and average between eight and twelve to the pound. Old trees bear them in great numbers in their crowns, but so far from the ground that one must use binoculars to observe them very closely. Trees apparently begin to produce cones when they are about fifty years old; even these young trees occasionally bear such quantities of cones that their slender tops are broken or deformed by the weight. Seed of excellent quality has been obtained from trees sixty to seventy years old as well as from veterans which have withstood the storms of two thousand winters.

An interesting and very significant fact is that a great many of the cones remain on the trees unopened for several years after the seeds mature. Some which have stayed on old trees long enough to become covered with lichen growth have yielded seeds which under test showed a germinative capacity of 42 per cent.

When they finally fall from the tree—some naturally, some blasted down by winter storms, some cut by squirrels for the food the seeds provide—the cones are firm in texture, bright green in color unless too old, and contain about 30 per cent

moisture. The seeds are held between the heavy cone scales and surrounded by a purple, crystalline resin which when separated out may weigh half as much as the seed in any given sample. One hundred pounds of green cones will yield from three to three and a half pounds of clean seed. The biggest cones of bright green color give the best seed, its viability generally averaging around 50 per cent or up to 75 per cent in selected samples of the largest seed. The general run shows 35 to 50 per cent viability.

What Seedlings Need

Sequoia seeds respond promptly when propagated in greenhouse seed flats or outdoor seedbeds under usual nursery care. Seedlings grow rapidly when placed in cans or other containers and may be transferred to the field when one to two years old. They develop a large root system and are difficult to transplant successfully when more than a foot high. When set in the field they need good care and some irrigation during the first dry season unless placed where they have shade from the hot sun during critical afternoon hours. Otherwise very large losses occur.

Under natural conditions seedlings are rarely found in mature forest stands. Seeds falling on the litter and humus of the forest floor are evidently not able to establish themselves. Occasional seedlings will be found on exposed mineral soil along roads or trails, particularly where moisture conditions are good and overhead canopy not too dense. Even under these conditions, root competition from larger trees is generally so severe that seedlings are stunted or killed out entirely during the first year or two.

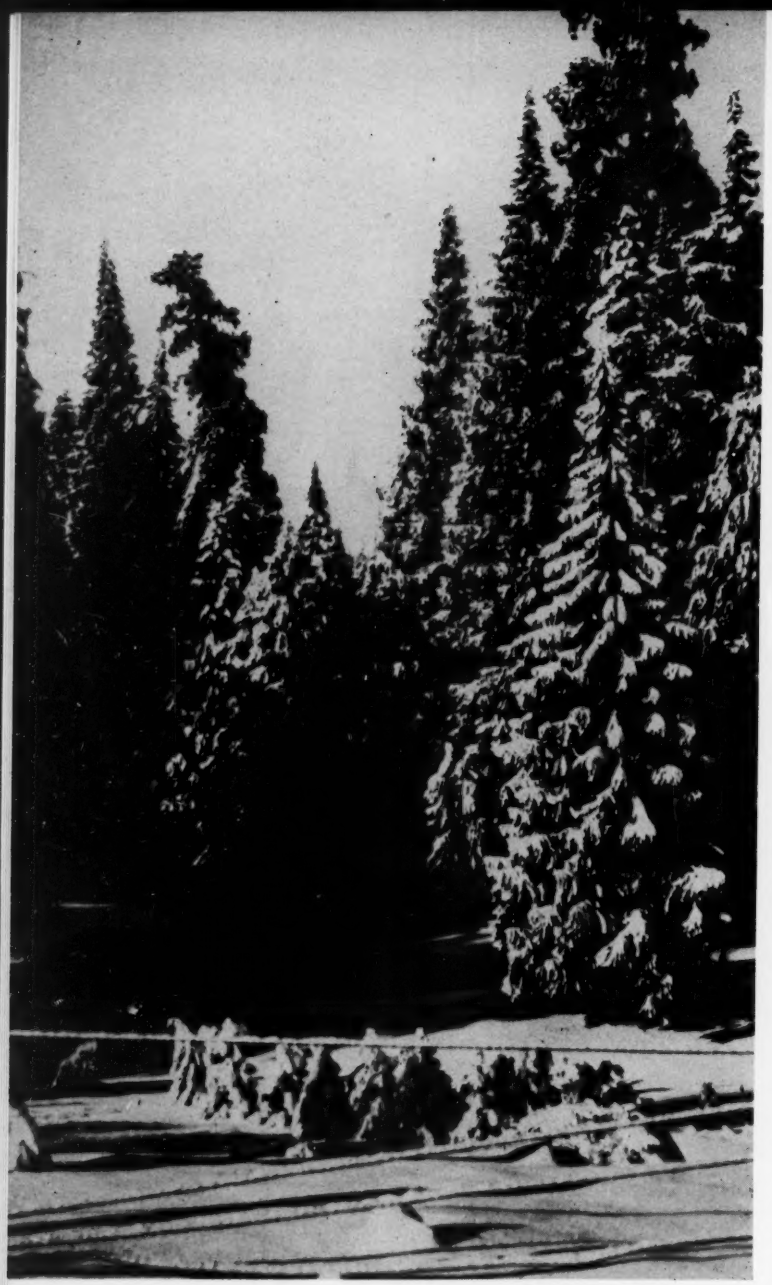
Thus it is evident that Sequoias, like white pines and other aristocrats of the forest, are quite fastidious about where they grow and require a special combination of favorable conditions to become established in large numbers. The beautiful young stands which did become established at Whitaker's Forest, Mountain Home State Forest, the Big Stump section, and similar restricted areas, were the result of a combination of favorable factors: (1) selective logging to open up the stand and expose areas of mineral soil; (2) adequate distribution of seed by squirrels or other natural means; (3) late rains in spring and early rains in fall during one or two years; (4) summer seasons free from extreme heat, dryness, and high winds; (5) successful fire protection for forty or fifty years.

The last is a most important requirement for the establishment of any young forest stand, though the use of fire to remove slash and other logging debris is a valuable aid in exposing mineral soil and providing suitable conditions for germination of seeds. Partial shade during hot afternoon hours and reasonable freedom from competition by roots of older trees are both of considerable importance. In general, Sequoias become established most easily along moist flats or on cool north and east slopes with sugar pine and white fir, leaving the drier sites to such drought-resistant species as ponderosa pine and incense cedar.

Struggle for Existence

Following the selective logging of the '70's in Whitaker's Forest, these factors combined to an unusually favorable degree. Germination of seed was good. Sequoia and other seedlings established themselves over a wide area, and as closely spaced as in a seedbed. This of course works two ways. Favorable conditions make for crowding, hence severe competition. During the first year or two the little trees are forced to fight for their very lives. Often one hundred or more seedlings will start to the square foot, and the fight for space to grow and the essential nutriments for life goes on continuously both below and above ground. In this struggle, which in many cases lasts for a hundred years or more, thousands will die and drop out where one succeeds. It is a great contest in which the victor in a local engagement must soon compete with other local champions in a gradually widening circle. Of all the starters, only an infinitesimal few win out to final victory. In the early months and years, moreover, outside influences such as rodents, grazing animals, frost, heat, drought, and floods all take their toll, to the advantage of trees which are most vigorous or fortunately situated. Thus, while greater vigor and rapidity of growth favor them, chance also aids the ultimate victors.

At the time the sample plots were established in 1915 the struggle had already been going on for about thirty-five years and showed no signs of letting up. Many dead trees had to be cut in order to give access to the plots for measurement of the living. Although their lower branches had been killed by shading, we soon found they were so numerous and so stiff and wire-like it was necessary to prune every trunk with a hand ax in order to tape-measure its diameter. At thirty to



When snow comes to Whitaker's Forest the slender young Sequoia crowns take on a new look as they bend gracefully under the white load. Occasionally some tops are broken by an overload of snow, but many quickly grow new leaders. This view across the plantation and swimming pool shows two veteran trees and their 65-year-old progeny. (Photograph by the author)

forty feet above the ground the crowns were so closely massed together that little sunlight came through, making it very difficult to identify tree tips for measuring total height. Three of the plots then showed a stand density of more than a thousand trees per acre, a large proportion of them in the most crowded areas definitely weakened by the severe competition. A few vigorous individuals, however, had forged ahead in the race for height, showing signs of the dominance which many of them have maintained throughout the succeeding years.

In Plot One where 358 Sequoias and four white firs were at that time crowded into a quarter acre, the trees in the upper crown classes averaged only 35 feet in height. In plots where competition was mainly with associated species and not with other Sequoias, the better trees averaged 45 to 65 feet in height at thirty-five years; and in Plot Five where the soil was deepest and the Sequoias had more adequate room for development, the better trees averaged 87 feet in height at the same age.

Study of the figures taken during the last thirty-two years shows that the Sequoias not only grow exceptionally fast when conditions favor them, but are remarkably tenacious of life under competition. In Plot One only 109 trees were alive in 1947 of the 362 measured in 1915; however, though eight trees per year had given up the fight on this small area, a number of the suppressed Sequoias still clung to life though they have grown less than a half inch in diameter during the last quarter century and their crowns show only faint indications of green foliage. This refusal to give up the fight, though undoubtedly an attribute of champions, tends to prolong competition for many decades.

How Trees Appeared in 1947

The following brief summary of each of the plots will give an idea of the growth and condition of the trees after some seventy-two years of competition.

PLOT ONE. On this fairly dry quarter acre at about 6,200 feet elevation there remain 35 Sequoias in the upper two crown classes, the only trees of the original 358 measured in 1915 which still have a chance of survival. They now average 13.4 inches in diameter and 90 feet in height. The five dominant trees, perhaps the only ones which will be alive after another twenty years, now average 16.9 inches in diameter and 99 feet tall. There are still 75 Sequoias living on the plot which have lost out in the fight and are now clinging to life by a very slender thread. They average only 4.6 inches in diameter and 22 feet in height. Four white firs which have been somewhat isolated in a corner of the plot are still doing fairly well and average 9.9 inches in diameter and 45 feet tall. But they have little chance of survival.

PLOT TWO. This one-sixteenth acre plot contained only 13 Sequoias in 1915, and these were well distributed so that all had a fairly adequate chance for growth and development. They made rapid progress for the first decade, but more than half were badly broken by an ice storm in 1932. Road building took out one, and the falling of timber in 1947 broke several. The surviving four average 19.3 inches in diameter and 96 feet in height. One has a broken top but is recovering.

PLOT THREE. This quarter acre is on fertile bottom land along a fork of Eshom Creek at 5,400 feet elevation and when measured in 1915 was a good example of a mixed stand. Of the 251 trees then occupying the ground, 131 or 52 per cent were incense cedars. There were 64 Sequoias, 35 white firs, four ponderosa pines, four sugar pines, and 13 hardwoods—oak, alder, and willow. Now there are 29 Sequoias which average 26.2 inches in diameter and 112 feet tall, 12 cedars with average diameter of 8.3 inches and height of about 50 feet, and seven white firs averaging 17.4 inches in diameter and 120 feet in height. All other species have died out. A few white firs have held their position because favorably placed, but the Sequoias clearly dominate, unchallenged.

PLOT FOUR. Situated on moist bottom land west of Eshom Creek, this one-sixteenth acre plot in 1915 also contained a mixed stand, 76 conifers and one willow. There were 20 Sequoias, 16 of which still remain after thirty-two years. Nine are in the upper crown classes, averaging 19.1 inches in diameter and 97 feet tall. The cedars have fared badly in the contest, only 11 remaining of the original 26. These are all in the lower crown classes, averaging but 5.2 inches in diameter, their crowns hopelessly overtopped. The white firs have fared about the same, with but five out of nine remaining, their average diameter 5.4 inches and height about 35 feet. Only four ponderosa pines are left of an original 16, but that they have done a little better on this site than elsewhere is shown by their average diameter of 14.5 inches and height of 75 feet. All five sugar pines and the willow have died.

PLOT FIVE. This plot shows astonishingly rapid growth of the Sequoias which had sufficient room for development on deep soil at the north end of the clearing. In 1915 there were 27 trees on approximately a quarter acre—20 Sequoias, six incense cedars, and a fine sugar pine apparently somewhat older than the plot's other trees. Ten of the Sequoias held dominant positions in the stand in 1915, nine of them exceeding 90 feet in height. These dominant trees continued to push their slender, feathery tips upward nearly two feet a year; in 1947 nine of them averaged 158 feet in height and 42.5 inches in diameter. The other 11 Sequoias were thinned out of the stand in the spring of that year to give the rest more growing room. Ring counts on the stumps of these trees put the age of the stand at some seventy-two years. The four remaining cedars have not had much competition from the Sequoias and average 24.9 inches in diameter and 72 feet in height. The sugar pine stands

Fifty-year Sequoia second growth in Plot One. Densely massed trees have here fought for living space throughout their lives. More than half of those which started as seedlings have lost out in the ruthless competition, which still goes on. (Photograph by the author)

in the open at one corner of the plot, a tree of great symmetry and beauty. It increased in diameter from 40.2 to 56.6 inches and in height from 108 to 140 feet during the thirty-two years. It is probably about one hundred years old.

PLOT SIX. Established in 1940, this plot is about half an acre of bottom land along the fork of Eshom Creek north of the swimming pool. In the fall of 1938 some 40 trees in the lower crown classes were thinned out to give the better trees room to grow. This left 35 Sequoias and five cedars. When measured in 1940 the Sequoias averaged 21.5 inches in diameter and 113 feet in height, the largest diameter being 39.6 inches and the greatest height 143 feet. The five cedars were all suppressed by the Sequoias, showing an average diameter of only 10.2 inches and height of only 42 feet. Though the thinning was not heavy the trees have responded to the partial release from competition with an average diameter increase of 1.9 inches during the past seven years. Their average height is now estimated to be about 125 feet. It is evident that about one-third of the remaining trees can be removed during the next few years in order to stimulate growth of the others. The final stand on this half acre will probably include at one hundred years of age only ten trees. All the dense young stands are now being similarly thinned in order to relieve the excessive competition which otherwise would continue in them for many years. The dominant trees, Sequoias with an occasional well-placed white fir or pine, are generally in vigorous condition for future rapid growth.

The observations and measurements we have made in these plots bring out facts which may be briefly summarized:

(1) Sequoias grow more rapidly in height, diameter, and volume than any of their associates. The height growth of well located, dominant trees on good soil has averaged two feet per year for over seventy years.

(2) Sequoias will unquestionably dominate any stand in which they start on fairly even terms with any other tree species.

(3) The thickness and relative fire resistance of Sequoia bark after about forty years give them an added advantage over other trees.

(4) Sequoias in young, pure stands are so tenacious of life that periodic thinnings are desirable to relieve the better trees of excessive competition and maintain a satisfactory rate of growth.

(5) Young Sequoia trees have an ideal length and form for use as telephone poles, a fact which makes intermediate thinnings economically feasible.

With respect to forest economics, Whitaker's Forest furnishes an example of the future possibilities in a mixed timber stand dominated by Sequoia. During the past few years mature trees of white fir, sugar and ponderosa pines, and cedar have been selectively logged, throughout the forest's 320 acres, for the market. This sale of timber has removed approximately two million board feet of mature trees with very little damage to the young timber stands. This has made openings in the crown cover and exposed areas of mineral soil which should provide excellent seedbed conditions for new reproduction when favorable weather occurs. Some advanced growth of white fir is already on the ground and more will follow the next good seed crop. These young firs will be marketed as soon as they reach Christmas tree size and thus add moderately to the Forest's financial return. While the Sequoias will probably always make up the bulk of the trees in these stands, there are considerable numbers of sugar pine, ponderosa pine, fir, and cedar which will grow to merchantable size for posts, poles, and eventually for lumber. Thus it is estimated that under intensive thinning and forest management during the next quarter century the annual volume growth per acre will increase to at least 500 board feet, of which about two-thirds will be Sequoia. This will amount to an annual yield of 160,000 board feet of logs from the 320 acres besides poles and other products removed by continual thinning for relief of unproductive competition in the young stands.

Looking Ahead

The young stands at Whitaker's Forest have demonstrated the remarkably rapid growth rate of *Sequoia gigantea* during its youthful years. It is not a difficult tree to plant, and indications are that planting can greatly extend its natural range. Planted trees are making excellent growth at many points in California and as far north as Portland, Oregon. Extreme cold and dryness are its chief natural checks. Thus it is altogether likely that this noble tree may yield large quantities of lumber and other forest products from forest areas where it is now unknown, as well as from natural stands under modern, intensive forest management.

But above all, it is heartening to know that this greatest of trees will continue to spring by its own seed from its native Sierran slopes for untold generations, so only man does not destroy it in greed or carelessness. If man wills continued life to this small remnant of a once earth-circling forest of giants, only another and greater Ice Age, perhaps, can end its time on earth.

Gateway to Havasu—Topocoba Canyon, near the head of the trail to the Havasupai Indian Reservation. (Grand Canyon National Park photograph)

PHILIP FERRY

Marble Falls of Havasu

THAT ENCHANTED CHASM IN NORTHERN ARIZONA known variously as Indian Shangri-La, Desert Eden, Canyon Paradise, and by other titles equally utopian, holds in its depths a superlative natural phenomenon that has been little publicized. This neglect may be owing to two facts—that so few people have seen the canyon, and that those who have visited the region have found the canyon scenery so enchanting and the Havasupai Indians so interesting they have neglected to comment on the spectacle here described.

Havasu (Hah'-va-soo) Canyon, to give it its correct name, is part of the Grand Canyon system. Havasu Creek drops from the Coconino Plateau into Grand Canyon National Park, through the Havasupai (Hah-va-soo'-pi) Indian Reservation which is entirely within the park, and joins forces with the Colorado River at the park's west boun-

Havasu Falls. Above, the lip of an older fall "turned to stone" in the ancient travertine deposit. (Santa Fe Railway photograph)

dary. The Havasupai occupy about three miles of the canyon's length. The rest of the canyon is a rugged region of primitive grandeur with a series of waterfalls which are among the loveliest on this continent. Only their isolation and the lack of publicity has kept them from becoming a mecca for tourists. There are four of these beautiful falls, named, successively, Navajo, Havasu, Mooney, and Beaver—Mooney being named for a prospector who fell to his death, some sixty years ago, from a rope which caught in a crevice while he was having himself lowered over the canyon wall.

Only a few hundred travelers have visited Havasu Canyon and set eyes on the gem-like falls. The canyon lies in a vast, all but uninhabited region larger than many an eastern state. To reach it, one turns north from U.S. 66 about six miles east of Peach Springs, Arizona, taking a dirt road for something over fifty miles across the northern Arizona plateau country to a jumping-off place called Hilltop.* From here saddle horses carry one down the Redwall to the Havasupai village in the canyon below.

The road is rough; the trail trip strenuous—but the traveler is well-rewarded. Not only have these falls great beauty; they make the canyon a working laboratory for one of nature's most interesting phenomena. The waters of Havasu Creek are so impregnated with lime they are one of the most active mineral-building agents in the country. The concentration of lime is heavy enough to give the waters of the stream a turquoise hue, and this is reflected in the tribal name, Havasupai, a compound word meaning "people of the blue water."

Wherever the creek water is arrested in its flow and evaporates, it leaves behind a lime deposit upon everything it has touched. When built up by gradual deposition, compacted and hardened, this material is called travertine, a kind of marble. Havasu Creek is fed by spring waters which have leached calcium carbonate out of the Kaibab limestone overlying the plateau through which the Grand Canyon and its tributary canyons have been cut. (Lime is so abundant in this region that one large side canyon is appropriately named Carbonate Canyon.) The mineral is carried in solution as calcium bicarbonate. Evaporation takes away both the solvent—water, and a gas—carbon dioxide. Calcium carbonate is left, in the form of the mineral calcite, here called travertine. A marvelous transformation has taken place: the waters of Havasu Creek have transformed the dull gray-white limestone of the plateau into the beautiful marbled mineral of Havasu Canyon.

The deposition accumulates in three distinct forms. The first takes place at the waterfalls. In tumbling over the falls the water releases clouds of lime-impregnated spray which dashes out on all sides. When the water in the spray evaporates, a minute film of calcite is deposited over the surrounding canyon walls, on rocks and soil, on trees, twigs, branches, and stumps. Everything the spray touches begins immediately to take on an outer layer of stone.

Oddly enough, these calcite deposits do not necessarily kill quickly. Deposition is so slow the process may go on for years before bringing about the death of a tree. But because the stream flows

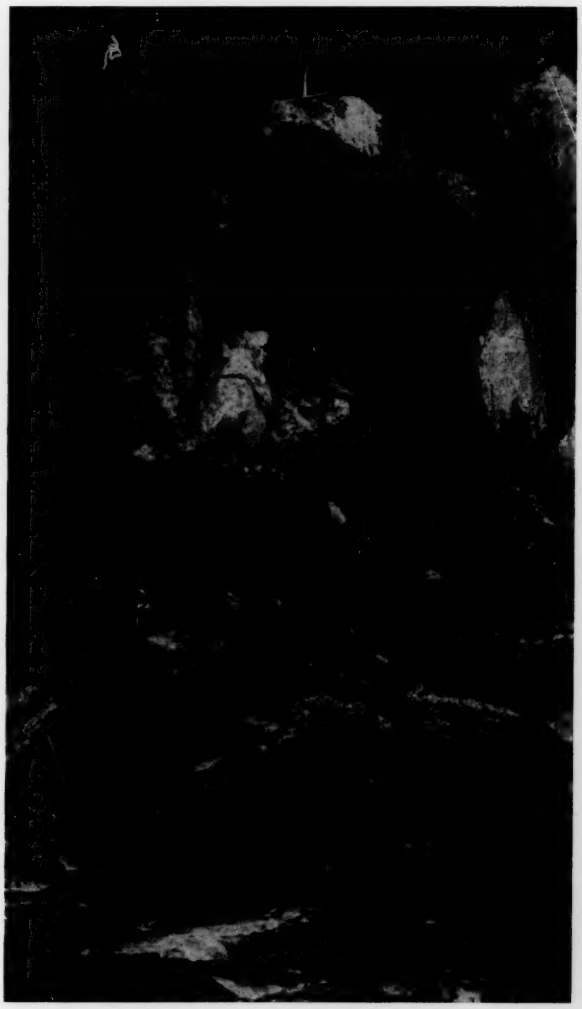
*To make things confusing, there is another jumping-off place for the Havasupai village, also called Hilltop, but reached by an even poorer road from Grand Canyon Village on the South Rim.—*Editor.*

the year round, the process goes on endlessly. Among its most interesting products are the accretions which frequently form around logs and sticks. A piece of wood may at length become completely surrounded by a shell of travertine anywhere from an inch to twelve inches thick. When in the course of time the wood itself rots away, it leaves behind a cylindrical rock formation in the enlarged shape of the formerly enclosed wood.

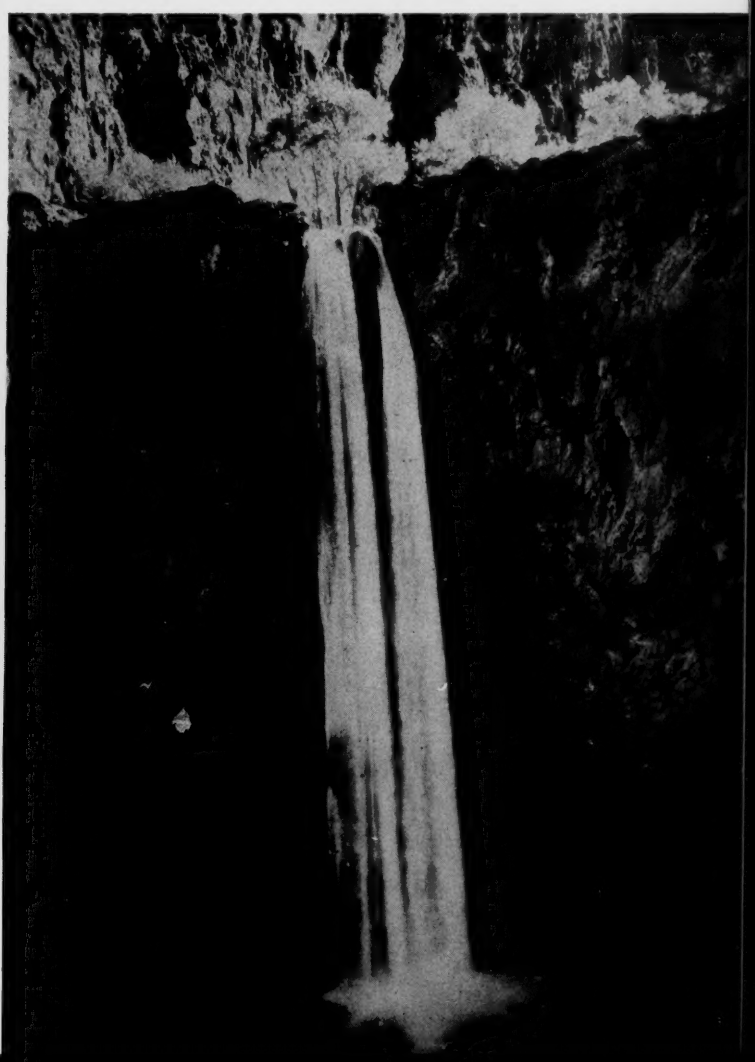
A second type of accretion is that in which the creek water builds small lime dams across the stream, producing a sort of "lilypad" effect. At the base of each waterfall is a series of these low terraces. To step into one of these pools is to stir up whirlpools of the milky calcium strewn over the stream bottom. In some instances the entire run-off course will be a snow white, calcite-lined trough through which flows a fairy-like turquoise stream.

One striking feature of this process of calcification is that unlike petrification—results of which may be seen in California, Yellowstone National Park, and Petrified Forest National Monument in Arizona—the deposition in Havasu Canyon is not a prehistoric occurrence, observable today only in static, finished form; it is an active, working process that is going on openly and continuously where we can watch it, a natural wonder in the making.

A first glance does not reveal how much calcification has taken place in this region. Great "boulders" that have broken away from prehistoric terraces and hillsides often prove to be masses of calcified material—stone, soil, logs, and branches—solidified into one body and held together by the cementing action of the lime. Between Navajo and Havasu Falls is a broad plateau over which the main canyon trail passes. On investigation, this mesa proves to be a massive heap of cemented rubble, riddled with logs and other debris, and situated on the opposite side of the canyon from



ABOVE: *Trail through caves at Mooney Falls. Figures are visible in upper right corner, at left above center, and at lower left. Havasu Creek in foreground. Limestone "canopies" are conspicuous in upper half of the picture. (Photograph by Elsa Bailey)*



RIGHT: *Mooney Falls plunging through a notch in the travertine lip built up through former geologic times. (Grand Canyon National Park photograph)*

the present-day stream. Mooney Falls, the most beautiful of the quartet, is set in an amphitheater where the surrounding travertine walls are so honeycombed with detritus that the Park Service, foregoing the usual practice of building a foot trail down the face of the cliff, dug an approach down through the interior of the soft travertine, forming a series of interesting caverns through which one descends to the base of the fall. In fact, it is told, some such tunneling was done in the effort to reach the ill-fated Mooney as he dangled from his snagged rope.

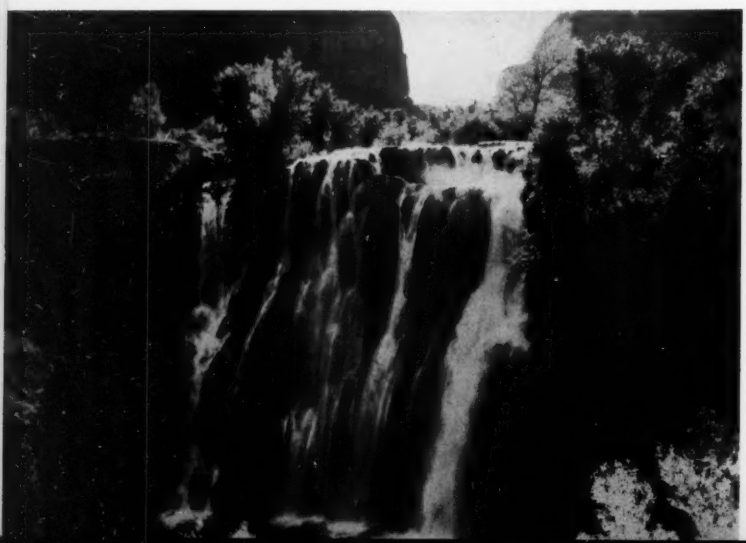
At Mooney Falls is found the most striking example of the third type of accretion occurring in the canyon. In this instance the side walls surrounding the falls are festooned with hanging stone drapery and mineral filagree work as intricate and delicate as though created by a skilled lace-maker. These travertine festoons, formed by the lime-impregnated spray from the falls, have the appearance of cascading water that has been instantly solidified into the graceful, curving lines assumed by falling spray. Like a prehistoric stream that has left its imprint in an ancient fossil bed, the travertine seems to have captured likenesses of the waterfalls and printed them indelibly on the walls. In some instances an entire amphitheater will be festooned with a series of these stone canopies overlapping like the multiple folds of a ballet skirt, to give the effect of water fluttering lightly down the face of the cliff.

At Havasu Falls the deposits have accumulated to such extent they form a stone hood which stands out fifteen feet from the wall. This hood acts like a giant umbrella which deflects the water outward from the wall, causing it to tumble down the face of the cliff without wetting the wall behind. Since the stream has shifted its course many times over the centuries, there are other canopies far removed from the present stream.

In one respect the falls in Havasu Canyon are the reverse of ordinary falls for they are building rock while most others are wearing it down. The waters of Havasu Creek build a calcite "lip" at the edge of each fall. This lip grows higher and higher with time until ultimately a barrier is formed which cuts off the flow of water, forcing the stream to seek a new channel. As the pressure of the accumulated water held back by the travertine dam increases, the stream breaks through at some weak spot in the walls and a new channel is formed. This action has been going on for ages, with the result that every one of the existing falls is surrounded with the evidences of old abandoned channels, with today's stream tumbling over only a small portion of the enclosing amphitheater.

The process of accretion taking place in Havasu Canyon is comparable to that which forms the stalactites in Carlsbad Caverns and others. It is also similar in effect if not in cause to the process of accretion which takes place about the geysers and hot pools of Yellowstone. The chemical composition of the Havasu deposits is essentially the same, but in the Yellowstone and other thermal regions colonies of micro-organisms, particularly algae, flourish in the more temperate of the heated waters, and are agents for the precipitation of calcium carbonate. The product here is loose and spongy, unlike travertine, and is called tufa, or calcareous sinter. In Havasu Canyon, on the other hand, the precipitation is clearly the result of evaporation which is very rapid in the arid climate.

Another uncommon aspect of this region is that one goes *downhill* to reach the falls, viewing them first from the top. Near its northern end Cataract Canyon (Havasu's other name) is, like the Grand Canyon, a double gorge. The first gorge is a mile wide and a half mile deep and cleaves through the white limestone formation. The second or inner gorge is narrower, only three to five hundred feet deep, and winds through the red sandstone strata in the bottom. To the northward, the canyon drops away by the series of steps that make the falls, to join the Gand Canyon of the Colorado River. The Havasupai village in its green little valley is shut in on all sides by towering cliffs which can be scaled in but few places. Tumbling away below the village and gardens, the creek plunges over the succession of vertical cliffs, in the falls that gave the name to Cataract Canyon.



Navajo Falls. (Grand Canyon National Park photograph)

CLOUDS AND WEATHER

Gayle Pickwell

DURING JUNE AND JULY—in fact, often throughout the year—the cloud that Far Westerners near the coast see most frequently is the *advection fog*, which drifts in almost daily from the Pacific and covers the sky with a smooth gray mantle. This cloud—formed when water vapor carried by warm air condenses as it passes over colder ocean waters—will strike San Francisco below the level of the tallest hills, and down the Peninsula it may be seen soughing over the slopes. In the Santa Clara Valley it will form a smooth gray cover which makes the Californians in this region frequently say it is merely "high fog." Then, too, the Californians, when they see this cloud during the summer or at any time during the year, are certain to exclaim, "Doesn't it look like rain?"—though they know that no rain is likely to fall during the summer, and especially not from a cloud like this.

Photographs by the Author

The advection fog is seen oftenest from its lower surface, but it is a thrill to see this same cloud from some elevation of near-by mountains. No greater thrill lies in store for the lover of weather forms than a journey along the nearest road leading to an elevation that puts the cloud below. Then a view back will show the advection fog from above, and when seen from above this cloud looks like an angry sea fast frozen, for in it there is no movement.

The Redwoods of the coastal region, it is very interesting to note, depend on the advection fog for their existence. Beneath the Redwood this fog will be precipitated to the ground like slow rain, for the needles of the big trees trap the cloud particles, coalesce them, and bring a slow dripping of water to the ground. If there were no advection fog along California's central and northern coast, the moisture-loving Redwoods could not live here, for it is this fog that gives them the necessary moisture at a period of the year when rains do not fall.

During the rains of winter the typical cloud sequence may be presented without any hint of the advection fog. After the sky has been blue for a period of time there will appear first the feathery tufts of cloud which are known as *cirrus*. The cirrus clouds are the forerunners of other forms to come. Shortly after the first cirrus there will appear a fusion of it into a gray layer, and it will then be *cirro-stratus*. The cirro-stratus will be followed by heavier and heavier clouds, until finally the sky is darkened by the *nimbus* or rain cloud. The nimbus may make a black cover, and if it is nimbus rain will come—slowly or torrentially.

The nimbus may last for a period of hours, throughout the night, and even through the following forenoon; but it will break at last to change into fragments of cloud, *fracto-nimbus*, and very shortly thereafter there may be clouds presented in spectacular masses.

Soon the sky will be clear, may remain clear for many hours and during the following night, but next morning a new series of clouds will appear, the "fair weather clouds." Clearing weather may present some of the most striking of all clouds—those which appear high in the sky like "little scales," as they were once called. These "little scales" are *cirro-cumulus*, and may group into definite rows. The rows of little cloud puffs are *alto-cumulus*.

During this morning of the first clear day following the rain, *cumulus* clouds may form. The cumulus, most beautiful of all clouds, are formed because the air near the earth is heated under the bright sun and is moisture-laden. Since the air is heated it rises, and as it rises its moisture condenses to form these grandly beautiful clouds.

Cumuli, even though the northwest wind blows, sometimes group in such masses that they are called *cumulo - nimbus* because although their fringes are light in color, parts of their masses may be dark; and from these dark portions showers may fall. These have been called high-pressure showers. After a high-pressure shower the cumulo-nimbus clouds quickly disappear and fair weather follows. Fair weather, rainy weather—year in, year out, the cycle is written across the sky in the age-old pattern of the clouds.

1. Advection fog from above as seen from a point in the Santa Cruz Mountains, the Mount Hamilton range in the distance.

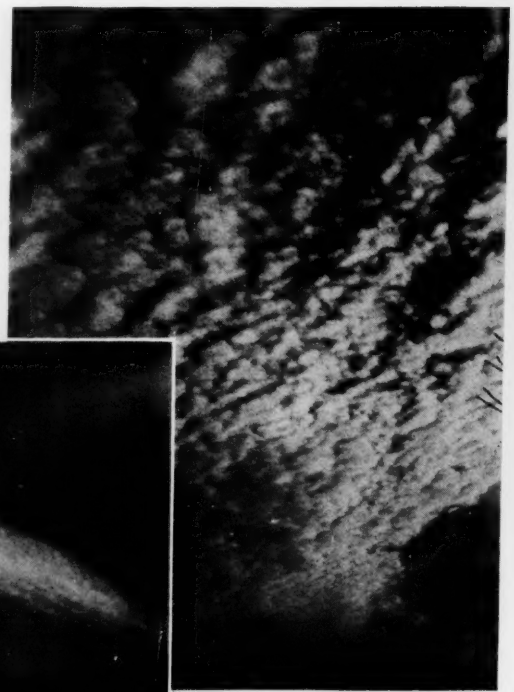
2. Advection fog drifting through the Redwoods of the San Lorenzo Valley in the Santa Cruz Mountains.

3. Tufts of cirrus clouds.

"The Age-old Pattern of the

6. (BELOW) *The first day of clear weather may show a banner of cirro-cumulus clouds.*

7. (RIGHT) *Cirro-cumuli may gather in large amounts and become the alto-cumuli on the morning of the first clear day.*



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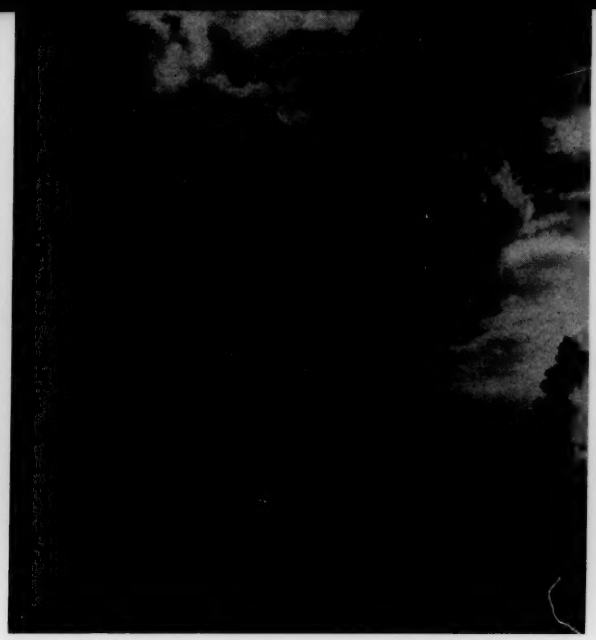
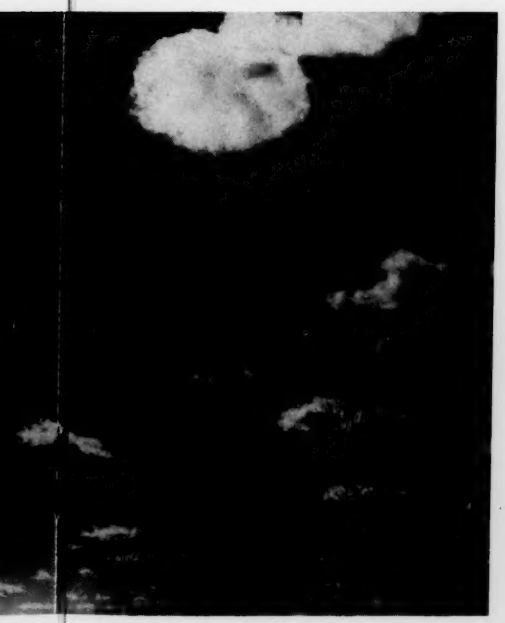


4. A wind-broken, or fracto-nimbus cloud over the Mohave Desert.

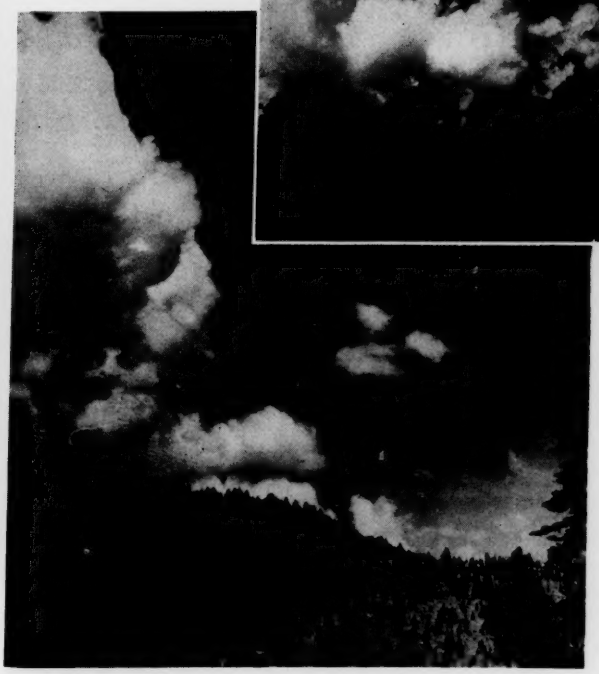
5. Clearing sky with wind-broken or fracto-stratus clouds.

n of the Clouds"

9. (RIGHT) If the northwest wind causes the cumuli to have ragged edges they are then fracto-cumuli.



8. The clouds that form during the middle of the clear day are cumuli.



10. The towering mass that results from a gathering of cumuli is the cumulo-nimbus, or thunderhead.

EARLE G. LINSLEY

Discovery in SPACE

THE GREAT TELESCOPE ON MOUNT PALOMAR has been described many times in print, yet no description can do it justice. This writer has stood beside it in the vast observatory dome. Earlier, he saw the giant glass in Corning, New York, and from time to time had glimpses of its preparation at the California Institute of Technology in Pasadena. He has given scores of illustrated lectures about it as, through the years, it has advanced toward completion. Yet it remains a thing to inspire awe and wonder.

Dr. Max Mason, Chairman of the Mount Palomar Observatory Council, has described the creation of the 200-inch as an "experience in coöperation." Possibly it outranks anything yet attained in concerted technological effort.

Project in Discovery

The Palomar project has not only been coöperative beyond anything yet attempted; it has been a project in discovery. The building of this great telescope—from the day that there was found a sponsor in the International Education Board of the Rockefeller Foundation in 1928, and a glass works to produce the giant mirror at Corning, and a manufacturing plant in Philadelphia to construct the framework to carry it, and a staff to perfect it and a mountain to erect it upon—has added impressively to the records of discovery, in the solving of new problems in physics, optics, and engineering. New discoveries in the unexplored reaches of the universe loom large in the calculations of astronomers as they plan the uses of this their greatest instrument.

While all other phases of the project were being carefully carried forward, the search for a site was under way. Some five years of observing and testing atmospheric conditions satisfied those seeking a place to set up the instrument that on Mount Palomar, forty-five miles northeast of San Diego, there was a satisfactory site. In a short time this almost unknown mountain became nationally famous. A splendid highway now reaches its summit. This year many of you will have your first vacation opportunity to drive to the gates of the new observatory, to stand in awe before the beauty of its great dome, and to exclaim in wonder at the majestic telescope.

Mount Palomar is 6,126 feet high, but the observatory is not located on the summit. Investigation revealed that a ridge forming part of the San Jacinto Mountains was a mass of granite, estimated to be at least ten miles wide, thirty miles long, and possibly twenty-five miles deep. Such a vast rock base under the observatory would, scientists believed, reduce to a minimum the chance of earthquake damage. Here the observatory building (pictured on the cover) now stands on the north edge of the flattened summit.

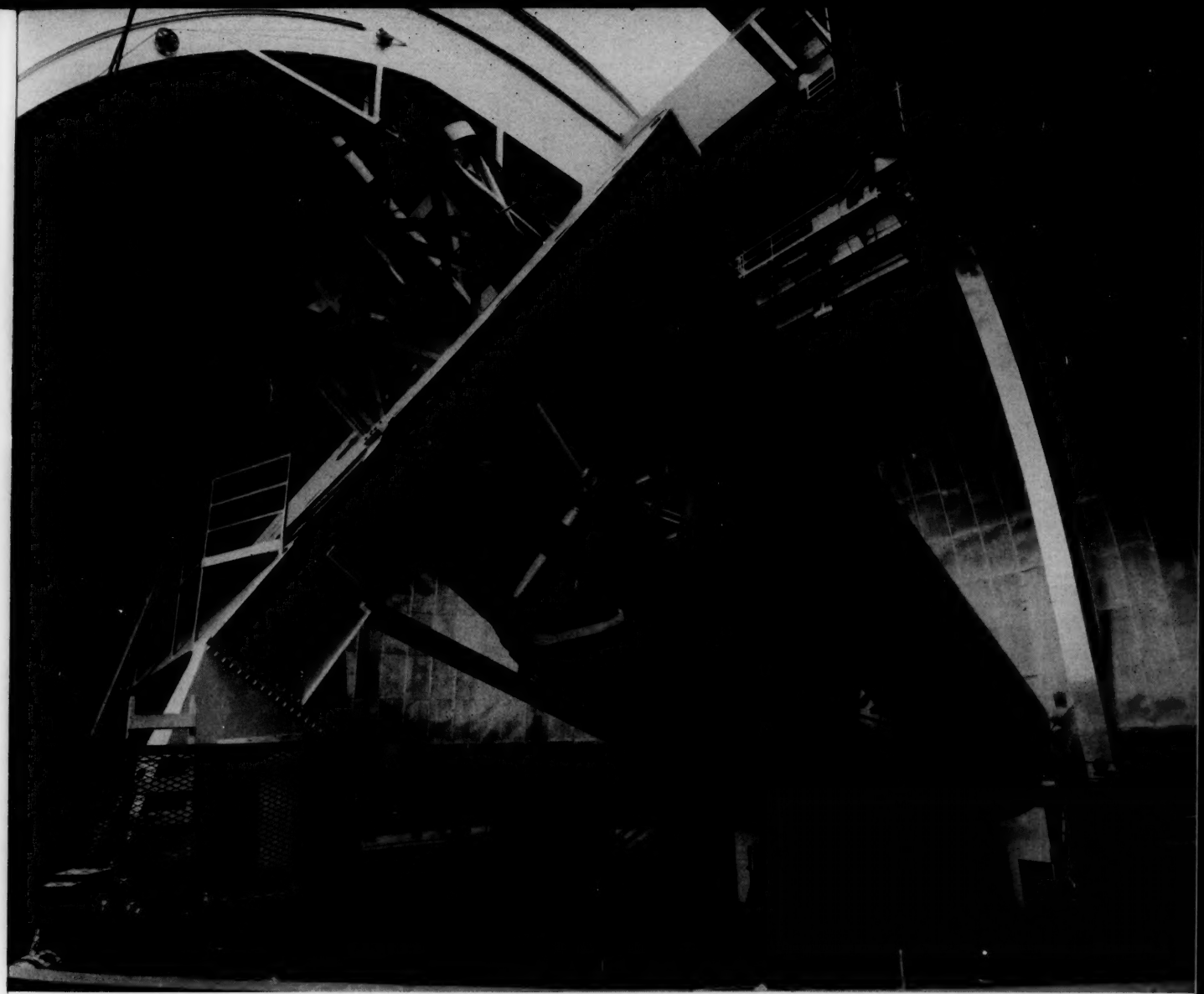
The Dome

In design and proportions perhaps one of the most beautiful buildings in the world, the domed observatory has a total height of 137 feet. The building is divided into two sections, easily recognizable in the picture. (Two persons shown on the balcony are a key to the scale of the building.) The lower part, rising 26 feet from the ground, is the foundation upon which turns the dome itself with its shutters (open in the picture). This revolving part weighs about 1,000 tons. Its surface, gleaming in the sunlight, is polished aluminum. The opening will permit the 200-inch telescope to be swung from horizon to zenith.

There are three main floors within. On the ground floor are the offices, photographic laboratories, library, lunch rooms adequately air-conditioned, and storage rooms. On the mezzanine are public rest rooms, the electrical equipment, and time service. A public stairway leads from the open doorway to the third—the observatory—floor, 5,600 feet above sea level. Here, more than a mile above the sea, in a glass enclosure, the visitor may stand and discover part by part this instrument, his amazement growing as his eyes explore its intricacies. It is a work of art, a masterpiece of scientific design, practical and utilitarian yet beautiful. The visitor should take time to study the design, to discover for himself all he can of its detail, the relations and purposes of its working parts.

Reflectors Old and New

It is a long jump from Isaac Newton's little model made in 1672, and still on exhibition in London, to the 200-inch reflecting mirror. Edison R. Hoge of Pasadena has provided us with a photograph showing a replica of Newton's first reflector which had a burnished metal mirror about one inch in diameter mounted at the base of a



The 200-inch telescope. The mirror, here covered by its shutter, is just above the base of the yoke, between its two huge tubular arms. The telescope cage projects beyond the horseshoe and supports the prime focus cage (pointing uppermost, left). Within the top of the latter sits the astronomer with his photographic plate. (Photograph by Edison R. Hoge)

tube about six inches long. A plane mirror set in the tube where the image was formed by the concave mirror projected the image to the eyepiece on the side, giving what is known to this day as the Newtonian focus. One set of optical parts of the 200-inch uses this principle.

The mirror so frequently pictured in the press may be described briefly as a circular block of pyrex glass cast in a mold with a grid to give ribs and to make a hole in the center. Of the casting's original weight of some twenty tons, nearly half has been removed in the final preparation.

In use, the mirror will intercept a beam of light 200 inches or 17.5 feet in diameter, which is equivalent to four times the amount of light intercepted by the 100-inch telescope at Mount Wilson. This light is thrown in a cone to the primary focus 55.5 feet above the mirror where it may be directed to a photographic plate. Actually, most of the work will be photographic. For this reason emphasis is constantly placed on the fact that this is a huge camera. Back from the primary fo-

cus the light may be reflected either through the opening in the center of the mirror or to the side, as in Newton's reflector.

To Discover—What?

The question most frequently asked the writer when he is lecturing about this instrument is: "What do the astronomers expect to discover with it?" It would be rash to give too definite an answer. Who knows what may be discovered a billion light years out in space? Even if this instrument should bring us nothing spectacularly new, even if it should prove that distant, still unseen galaxies are not very different from those we already know, the mere certainty of doubling the observable distance between us and a new "frontier" of the unknown was challenge enough to those who conceived it and built it. Its effect will be to add enormously to the number and variety of "samples" of the stuff of the universe available for study.

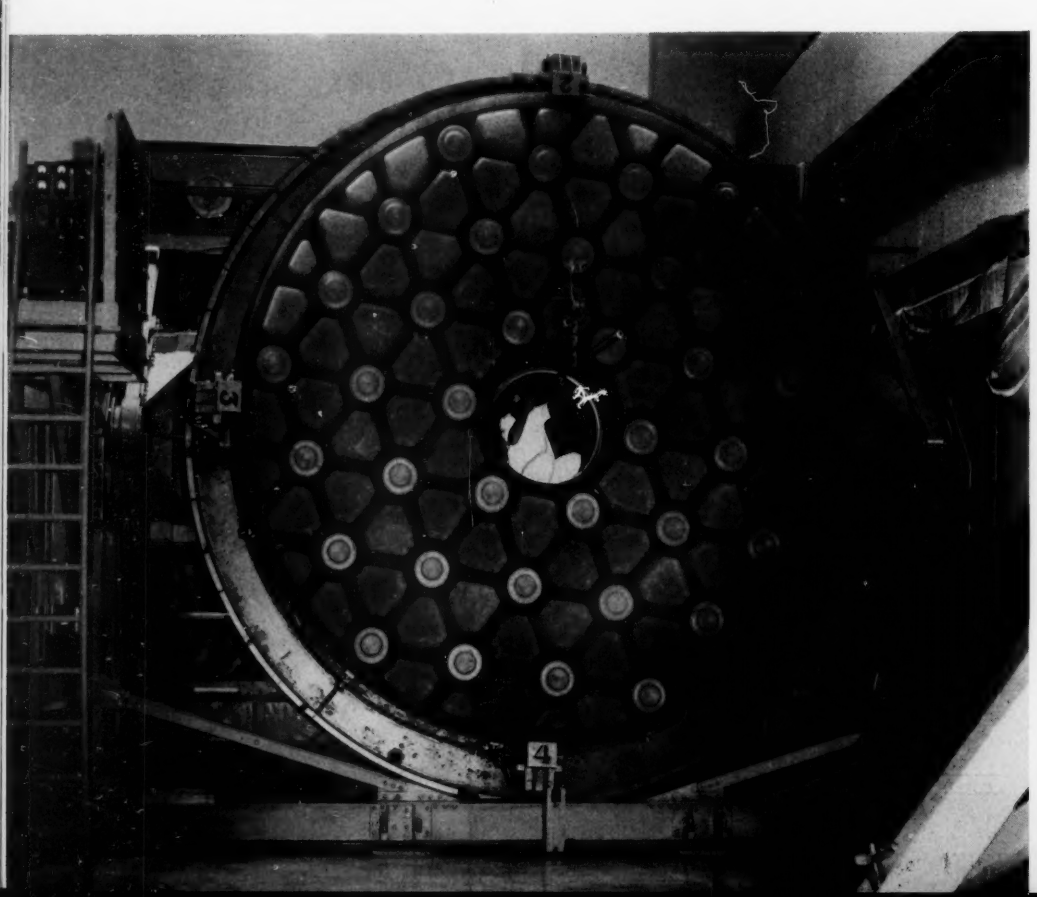
Since Edwin Hubble of Mount Wilson, outstanding authority on the nebulae and the depths of space, will no doubt lead in further exploration of these cosmic matters, we are outlining here part of a recent statement from him. In *Publications of the Astronomical Society of the Pacific,* August 1947, Dr. Hubble reviews the history of the telescope and names three types of problems to be investigated:

(1) Problems of our own solar system, such as the highly controversial question of the canals on Mars, in which photography may establish or disprove the validity of the theory of their existence.

(2) Spectrum analysis. The 200-inch because of its light gathering power will give wider and clearer spectra of stars and nebulae than any so far obtained. This will enable far more detailed analysis—qualitative and quantitative measurement—of the chemical elements whose presence is indicated by their characteristic colors in the spectrum.

(3) Cosmology, "the structure and behavior of the universe as a whole," in the words of Dr. Hubble. In this, he believes the new instrument may greatly advance our knowledge, as suggested above. Present theories have been derived from or have been tested by the information given us through our (heretofore) greatest instruments, especially the 100-inch. Since the new telescope will penetrate about twice as far into space, it will give science the means of further testing or revising the theories of today.

On the other hand, all the astronomers who expect to use the 200-inch telescope feel that it may introduce more problems than it solves, and thus again will the ingenuity of scientists be challenged to build again, perhaps a still greater, possibly a very different "discoverer" of what lies beyond.



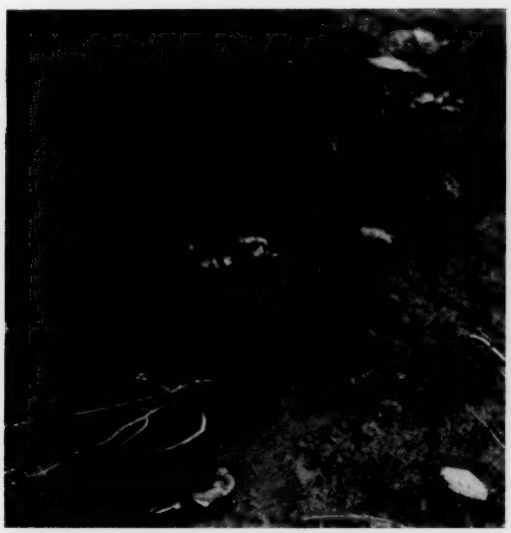
The 200-inch mirror tilted up to its testing position. The man in the center is holding a replica of Newton's reflector—one inch! (Photograph by Edison R. Hoge)

CLEAR WATER

A. STARKER LEOPOLD

THERE IS A CURIOUS VOID in the public conscience with respect to pollution of rivers and streams. In many respects the American people have become avidly conservation-minded. For example, the legitimate proposal to shoot female deer for the purpose of reducing excessive local populations frequently provokes a strong reaction from deer hunters and sentimentalists who fear that thereby the whole deer population will be endangered. Besides, it is considered unethical to shoot a doe. A recent attempt by lumbering interests to obtain logging rights on a section of Olympic National Park was bitterly fought (and fortunately defeated) by a host of conservation organizations. It has come to be an affront to the national interest and a severe breach of ethics to cut a tree in a national park. Such evidence of commendable public concern for some particular resource is not at all uncommon. Yet many of the same citizens shrug their shoulders when told of the tons of industrial waste or sewage or silt that flow down the rivers of their home state. That is a problem for the public health service or someone else. They see no obvious question of ethics in the polluting of a river.

In my adopted state of California I have encountered some disheartening evidences of water pollution. Though many of these constitute eyesores visible from public highways they cause little general comment or concern.

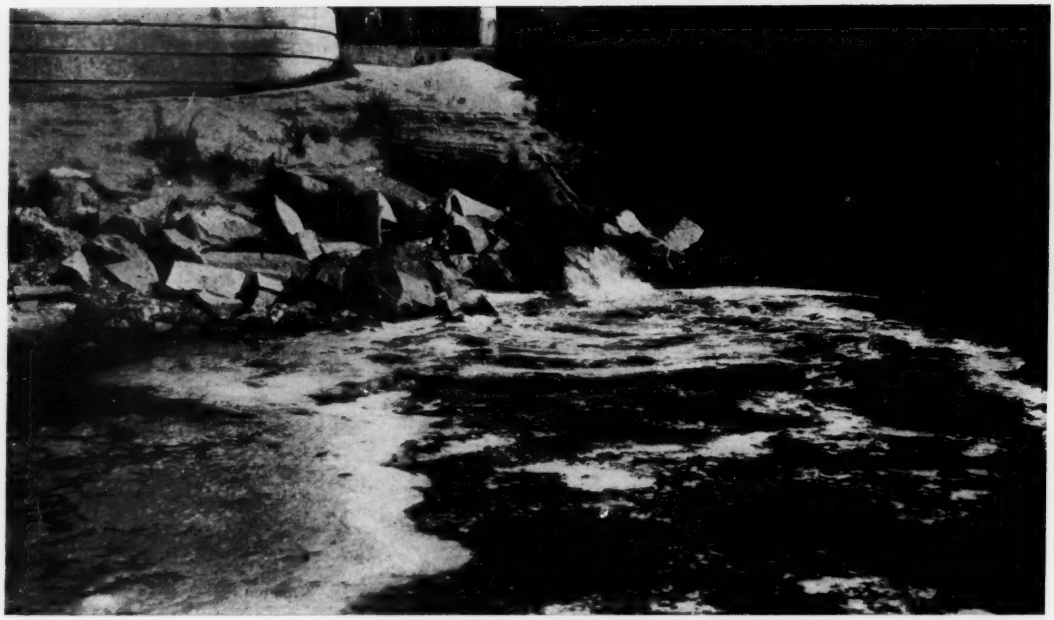


I have seen the tumbling waters of the Yuba River running brick red with clay from the hydraulic gold diggers. Some day this lovely stream —and many others like it—will wind over slimy mudflats of impounded silt so that the nation can be enriched by additional bars of gold, buried in the vaults of Fort Knox.*

I have tallied dead ducks on the Woodland "sewer farm," a few miles from the state capitol. The municipal sewage of the city of Woodland is run into open forty-acre ponds on a tract of land bordering State Highway 16, and there it is allowed to decompose until it is "safe" to dump into the Sacramento River. One day in the fall of 1947 we counted on these ponds over 7,000 dead and dying pintails, shovelers, and green-winged teal, as well as 1,000 coots and a scattering of swans, geese, and shore birds—poisoned by botulism and fowl pox. Probably twice that number of birds died during the year.

* See "Gold, Men and Fish" by Joel Hedgpeth in the last issue of *Pacific Discovery*.

The harvest of the Woodland sewer farm—dead ducks, 7,000 of which the author estimated at one time to be lying along the edges of the ponds or awash in the foul water and sewage muck. Like any picture of the results of pollution, these are ugly pictures of an ugly fact. (Photographs courtesy of Carl O. Fischer)



Sewage outfall on the Tuolumne River. (California Department of Public Health photograph)

I have fished in the filthy waters of the lower Sacramento River, aswirl with oil, chemical and organic wastes from the factories, sewage from the cities, and debris from wharves and docks. Striped bass taken in this water even taste of petroleum.

Do the people as a whole object to the loss of wildlife habitat, scenic beauty, and recreational values along the river banks? Occasionally, local groups of fishermen send a resolution to their representatives in the legislature or to the Fish and Game Commission. Now and then pressure is brought to bear on some particular factory or municipality to withhold from public waters unusually toxic pollutants that may be killing thousands of fish, or, as in the case of the city of Woodland, migratory waterfowl. But most of the waste still flows on. Under existing state laws, the best efforts of public health and fish and game departments can cope only with the most flagrant cases. Sporadic crusades by one or another of the conservation groups have not resulted in adequate legislation. The people of California collectively are simply not interested.

Nor is pollution much worse in California than in other states. A recent survey by the Isaac Walton League showed that only seven of the forty-eight states claimed as much as 50 per cent treatment of municipal sewage, and only one state claimed 50 per cent treatment of industrial effluent. The great bulk of the waste of American civilization is disposed of in the cheapest and easiest manner—dumped into the rivers to make its own way to the sea. California rivers carry somewhat of an extra load owing to silt from the gold mines and an undue amount of organic waste from wineries and canneries. At least we are spared the acid liquors from the coal fields of Pennsylvania or the paper mill wastes of the Lake and New England states—perhaps the worst pollutants of all.

In our zeal to preserve the mountains and faraway scenic areas we may be overlooking public recreational values close to home. Potentially the larger rivers near centers of population can furnish far more recreation in the way of fishing and swimming than the remote mountain parks and publicly acclaimed recreational areas. Yet it is the lower reaches of the rivers that carry the most sewage. In addition to the loss of recreational facilities, the resultant expense of treating polluted river water for industrial and municipal use probably equals or exceeds the possible initial cost of 100 per cent waste disposal. The potential increased take of salmon fisheries might almost bal-

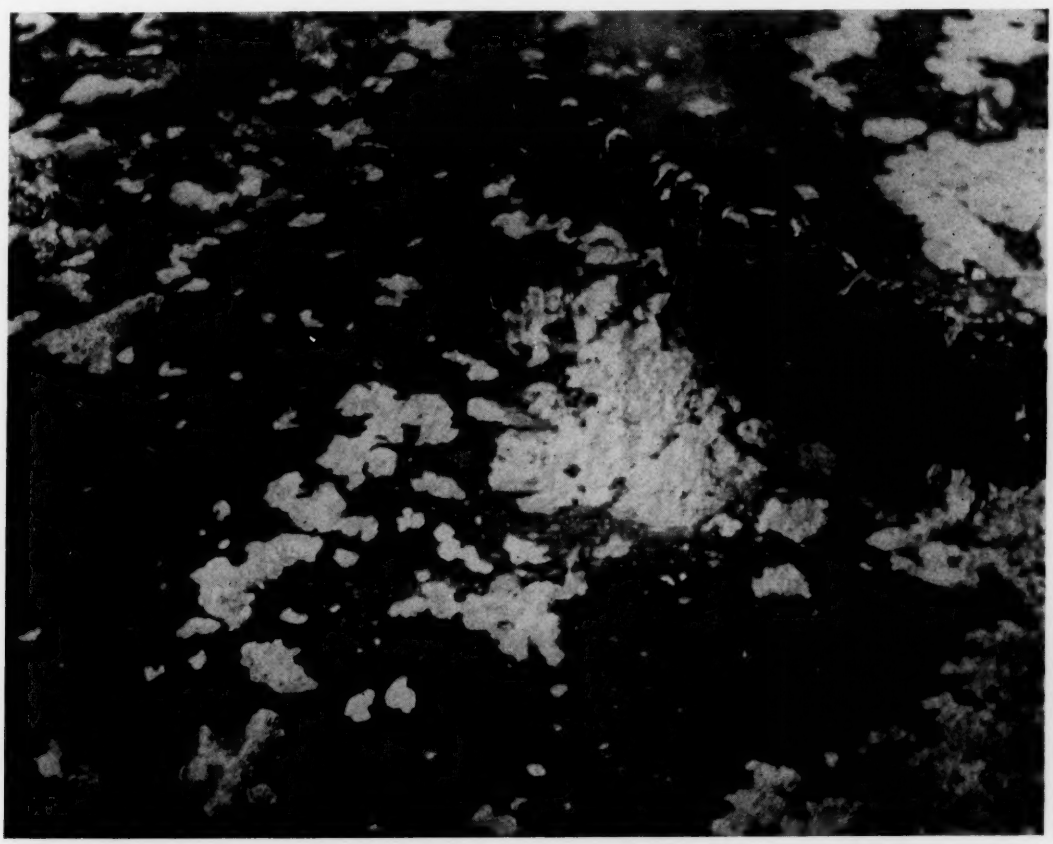
ance the cost of keeping all the rivers of the Pacific slope clean enough to maintain good salmon runs.

As a result of public apathy and the opposition of industry, present anti-pollution laws of both state and Federal governments are utterly inadequate. Since it is unlikely that all forty-eight states will ever pass and enforce proper laws, the only likely solution of the problem on a national basis is the enactment of a strong, publicly-supported Federal law requiring the proper disposal of wastes by industrial establishments and municipal governments. With few exceptions, the arguments of economic impracticability of waste disposal are not convincing. If some factories can dispose of their effluent and some cities can afford sewage disposal plants, so also can the rest. As for hydraulic gold mining, unless ways of settling the silt locally can be devised it should be prohibited completely. All the gold in California will not pay for the deliberate erosion and siltation caused by this destructive practice.

The fight to get a national anti-pollution law enacted has gone on for many years, supported in particular by the Isaac Walton League. But so far no such bill has been passed by Congress. The current Mundt Bill (H.R. 3990) is a good one, and it is being given serious consideration by Congress. But neither this bill nor any subsequent one will be enacted until the pub'ic has demonstrated its support.

Is not a clear river as much to be desired and protected as a forested park or a productive deer herd?

Here is stream pollution at its worst. Ugly to look at, foul to smell, this water can carry cholera, dysentery, typhoid, gastroenteritis, and skin diseases to all along its banks. Nor can fish or waterfowl live here. (Photograph courtesy General Electric Co.)



WALTER C. LOWDERMILK

The Eleventh Commandment

MOSES WAS INSPIRED to deliver to the children of Israel wandering in the wilderness of Sinai the Ten Commandments to regulate man's relations to his creator and to his fellow men. These guides of conduct have stood the test of time for more than 3,000 years. Did Moses, during those forty years in the wilderness, fail to foresee the vital need of the future for an additional commandment to regulate man's relation and responsibility to Mother Earth, whose cultivation and production must nourish all generations?

If Moses had foreseen what was to become of the "Promised Land" and vast areas of wasted lands, such as we have seen in China, Korea, North Africa, Asia Minor, Mesopotamia, and our own United States: namely, the wastage of land due to suicidal agriculture and the resulting man-made deserts and ruined civilizations, and social decadence of billions of people through thousands of years and the oncoming desolation of their lands, he doubtless would have been inspired to deliver an "Eleventh" Commandment to complete the trinity of man's responsibilities—to his Creator, to his fellow man, and to Mother Earth. Such a commandment should read somewhat as follows:

XI. Thou shalt inherit the holy earth as a faithful steward, conserving its resources and productivity from generation to generation. Thou shalt safeguard thy fields from soil erosion, thy living waters from drying up, thy forests from desolation, and protect the hills from overgrazing by thy herds, that thy descendants may have abundance forever. If any shall fail in this stewardship of the land thy fruitful fields shall become sterile stony ground and wasting gullies, and thy descendants shall decrease and live in poverty or perish from off the face of the earth.

But no such commandment has been a part of man's attitude toward his occupation of the earth except in very limited areas. Man has generally been an exploiter, despoiler, and destroyer of the natural physical, plant, and animal resources of the earth. He has brought upon himself the curse of destruction, impoverishment, and desolation in vast areas.

Man Destroyed Billions of Acres

Today literally billions of acres of originally productive lands throughout the world bear the curse of unfaithful stewards through the centuries, and their sins of land misuse are visited upon their descendants not only unto the third and fourth generations, but unto the tillers of exploited lands today. This curse upon the land, by generations of ignorance, neglect, lack of forethought, greed, or oppression of present individual interest over the social interest, represents a waste of humanity so stupendous as to exceed the comprehension of the human mind.

The world is now more fully occupied by the human race than ever before. Fully two billion souls must find their daily food from the land and waters of the earth. All lands have been occupied or possessed by nations. No free land remains.

In the face of the limited area now available to the human race, the idea that man is still destroying its usefulness by inconsiderate and wasteful methods, comes as a shock to thinking people. If man is making deserts out of productive lands it is a matter not only of national, but of world-wide concern.

We Need a New Concept

The overcrowded condition in a world of land-hungry nations, whose soils are being impoverished by erosion and misuse while populations increase, demands a new conception of individual

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This article• was written in the biblical land of Palestine as the author was completing a fifteen months' study of man's stewardship of land down through the ages in fifteen countries of the Old World. Traveling over 30,000 miles by train, airplane, automobile, boat, and afoot, Dr. Lowdermilk, as Assistant Chief of the U.S. Soil Conservation Service, surveyed the land as civilization has used it and passed it down to the present generation. His special interest was human use as it relates to soil erosion, soil and water conservation, and flood control. His studies took him into Egypt, Algeria, Tunisia, Libya, Trans-Jordan, Palestine, Lebanon, Syria, Iraq, Italy, France, Holland, Scotland, and England. As a background to this survey he previously had made five different explorations into the interior of northern China so that in "The Eleventh Commandment" he writes with a vivid world picture before him of the sins of civilization against Mother Earth.—*Editor, California Conservation Council.*

•Here reproduced in the interests of conservation by courtesy of the California Conservation Council, a non-political, non-profit organization whose sole objects are "to promote conservation education and encourage coöperation in conservation effort." A few deletions have been made to conserve space.—*Ed.*

and national obligation to the earth and to posterity. When men are unfaithful stewards in their use of the land they bring a curse upon themselves and upon succeeding inhabitants. They find the very source of livelihood washed away, gradually and diabolically impoverishing them. Life becomes such a struggle for mere physical existence as to warp and crush the human spirit, bringing on revolutions, wars, migrations, or political and social decadence. In time the insidious forces of soil erosion and land wastage reach proportions beyond the control and resources of individual tillers of the soil; wearied and discouraged, they migrate, rebel, fight, or perish in the wrecks of misused land.

Travels through the morgues of former prosperous areas, now desolate and depopulated, are depressing to one who reads the Macbethan tragedy written far and wide on the landscape. It is appalling to see ruins of once great cities, of civilizations and flourishing cultures, strewn like weather-beaten skeletons in the graveyard of their erosion-wasted lands. Behind all these ruins is the stirring drama of hunger, invasion, and destruction of life. Death of fertile lands and of their peoples is a nameless tragedy written across landscape after landscape.

Tragic Mediterranean Ruins

It fills one with consternation to visit regions which have lain desolate and unproductive for centuries with their beautifully cut stone dams completely silted up as at Kurnub, in the Negeb of Palestine, or terraces broken down as above Petra and Jerash, in Trans-Jordan, or aqueducts crumbled as in North Africa. In northern Syria, southeast of Antioch, we found erosion at its worst on a million acres of lands which supplied ancient Rome with its finest wines and olive oil. Here erosion has swept off of bed rock from three to six feet of productive soil and transformed the ancient vineyards into a vast and glaring man-made desert. In this desolation a hundred "dead cities," or villages, of beautifully cut stone, loom ghost-like as tombs on the horizon as evidence of the ancient prosperity of this populous area. Such areas were abandoned when the erosion-washed soils would no longer feed the inhabitants.

It was astonishing and revealing to find Mesopotamia literally covered with miniature mountain ranges of silt, some ten, twenty, and up to fifty feet in height, piled beside the ancient irrigation ditches. This silt, the offspring of erosion in overgrazed watersheds, tells a story of the ceaseless struggles of millions of nameless toilers, before the potentially rich irrigated lands were allowed to revert again to desert when, due to wars or political decadence, the cleaning of silt from the canals was no longer continued. This valley, which formerly maintained from 30,000,000 to 50,000,000 people, supporting renowned civilizations of culture, refinement, and learning, now maintains on a very low standard about 5,000,000, whose comforts and accomplishments are a sad commentary on the decadence of cultures.

The Negeb and Sinai region is believed by Jarvis to have supported fully 100,000 inhabitants, but now it scarcely suffices for 2,000 Bedouins. In Trans-Jordan studies by the American School of Oriental Research reveal an extensive ancient agriculture from more than a thousand years B.C. to the seventh century A.D. The loss of fertile soil and the resulting reduction of food supply from the lands of Trans-Jordan are greater than the proportional decrease in population. The food supply and the standards of living and embellished cities among the cultured ancients have little counterpart in the rough stone houses and wretched villages, and in the camps of illiterate Bedouins of today.

The Lesson of China

The staggering soil wastage of North China is unbelievable. Historical records show that mountain slopes of North China were once heavily forested. Populations increased and exceeded the carrying capacities of alluvial valleys, thereupon farmers cleared away the forests and pushed cultivation higher and higher up the slopes. Trees were cut, the fertile soils were dug up and planted to crops. In from three to twenty years, depending upon gradients of slopes, the soils were washed off and farmers abandoned these fields to clear new lands. Finally, this shifting cultivation was pushed up slopes to the summits. Accelerated erosion cut great gullies, and bared the rocky flanks of the mountains. Today, hundreds of millions of acres have been seriously reduced from production to barren slopes and labyrinths of gullies. Perennial streams are gone; lowlands have been damaged by debris from the slopes; old irrigation systems have been clogged and put out of use, while floods far away in lowlands and deltas of the rivers rise to higher stages and cause enormous destruction of life and property.

Some students have attributed this disastrous

loss of productivity, and dessication, to adverse climatic change. But throughout northwest China I found temple forests as green emeralds in ugly settings of gully-riddled landscapes, reproducing themselves naturally in the present prevailing climate. In several remote areas I found the diabolic process at work where a virgin forest was being cleared, not for timber, but to get at the soil for food production. The deep soils were sowed to crops; soil erosion soon destroyed the fruitfulness of the sloping lands.

In spite of this vast destruction by increasing populations hard pressed for food, the Chinese in the alluvial and rice growing areas are the world's best farmers. For 6,000 years they have farmed these lands which still produce four crops and more yearly. In west and south China especially, they have level-terraced all slopes by infinite labor and patience, and have shown what good stewardship of the land may be.

During five expeditions into North China prior to 1927, my experimental studies determined for the first time comparative rates and amounts of run-off and soil erosion from lands within temple forests and adjoining like areas which had been cultivated and denuded. We found that often sixty times as much water, in the form of liquid mud, flowed from cultivated and barren areas as from the forest. The run-off from the latter was scarcely disclosed, showing little or no erosion, while the storm run-off on denuded areas tore away the soil, causing permanent loss to the land.

On the basis of these measurements of widespread soil loss by erosion, my estimate is that soil has been removed to an average depth of from twelve to eighteen inches from hundreds of millions of acres of sloping lands in northwest China, by man-induced erosion. By such diabolical processes areas formerly capable of supporting great populations in prosperity, now provide meager existence for lesser numbers.

We Destroy Our Own Land

Until very recently, the desiccation and torrential flooding of inhabited areas was considered an act of a Supreme Being. That man may be the decisive factor to so-called vagaries of many natural phenomena is a recent conception. The rapid growth of this idea may be partly attributed to the fact that America has developed desiccated and unproductive lands more rapidly than ever before in the history of the world. Effects have followed so closely on the heels of causes that the reasons are glaringly obvious to students of land problems. Striking transformations have been visible to eye witnesses within a single generation. We have come to know soil erosion for what it is.

The exploitation of great areas, whether in America, Africa, Australia, or elsewhere, where farmers and stockmen have cleared and grazed new lands at a rate hitherto unknown, tell the same story. Within the memory of the present inhabitants of certain portions of the world, men have witnessed the transformation of fertile plains from luxuriant vegetation into barren, wind-swept, desert-like lands, periodically whirling blizzards of fine soils to parts unknown, and leaving behind sandy hummocks. Stockmen tell of grazing paradises, which within their day have been depleted of vegetation and gouged with gullies. People who paid taxes for the building of irrigation dams and reservoirs have already seen some of them abandoned and useless, while other reservoirs are silting up at an alarming rate.

The vast virgin forests of all these newly exploited continents have largely disappeared under wasteful exploitation. It has been annihilation rather than rational cutting with a planned maintenance of the forest for sustained yield, and for the control of erosion and flashy storm run-off. In a few countries such as Germany, Italy, and Japan, a high conception of the permanent value of natural resources for future national greatness has been developed as a vital policy of national planning. Germany and Japan were exemplary in forest and land conservation. Italy was rushing her program of conservation and reclamation as a basis for a greater empire. (This was written in 1939.)

Fortunately, though belated, a national movement for soil and water conservation has been initiated within the past few years which has aroused the American people to the menace of soil erosion. This enemy of civilizations has already destroyed or seriously impoverished 282,000,000 acres of American lands and impaired the productivity of 775,000,000 acres more. As a result, the United States has begun the largest and most comprehensive movement for soil and water conservation in the history of the world. But only a beginning has been made; it must be continued and enlarged.

If a nation would project itself into the future it must protect its lands from the ravages of soil erosion. When lands are impoverished, peoples

lower their standards, both physically and spiritually. Soil erosion expresses itself as a deficiency disease of the land which begets deficiency of food, vitality, and higher values for peoples and nations.

This is Conservation

Soil erosion, the destroyer of land, has been diagnosed; its processes are known and its control is possible. The hope for the future lies in a realization that man has an obligation born of a higher economics; a moral obligation to bountiful Mother Earth which must nourish all present and future human beings as long as it lasts. *It is nothing short of criminal for individuals of one generation to sacrifice the right of future man to survive because of traditions of special privilege to exploit the earth. The present and future well-being of a people calls for long range policies for the maintenance of productive lands and resources. These policies must be founded on what is right for the greatest number of people in the long run. It becomes a matter of social economics and national ethics. Practices of land use which work against the good of the whole must be regulated, whether by law or public opinion, to achieve a dual purpose: to maintain individual initiative, and to safeguard the integrity of resources.*

Economics of Survival

Exploitation is self limiting and suicidal. It uses up the principal and makes no provision for future balancing of the national resources budget. Finally when a nation is reduced to desperation to supply food for its people, it will go to an expense far beyond any tax burden yet known to cultivate diminishing soils. Rock wall terraces in old lands prove the Herculean labor and expense to which people will go to maintain a food supply; the cost of such terracing of steep lands would amount to several thousand dollars an acre at labor wages today. Yet such works were carried out to survive. The economics of survival prevailed.

Land thus becomes not an economic commodity, but an integral part of the corporate existence of a nation, even as its people. This principle justifies the safeguarding of soils and the restoration of denuded areas on a basis of national ethics and national economy. Economic considerations of today must be shot through with economics of a higher order to meet problems of sustained land use constructively for generations to follow.

Thus for the very endurance of civilization, an ethical approach to land use as a trusteeship, to be used and handed down in a productive condition to succeeding generations, becomes imperative. Man expresses his moral obligation to posterity as surely through the earth as through his social institutions. The fertile or sterile lands which are passed on to feed future generations are, apart from blood descendants, our most direct link with the future. The ethical motivation identifies the interests of the individual with those of one's own family of today and tomorrow, outward through local groups to the nation, and eventually to mankind. It draws support and depth from experiences of the past to long range vision and conservation for the future.

Each nation today needs to have many a Moses of land conservation, to instill in the national consciousness the principle of an Eleventh Commandment to regulate man's relation to the holy earth as a faithful steward, to conserve its productivity from generation to generation. The fields will be protected from soil erosion, water brooks from drying up, and hills from overgrazing by herds, and future generations may be assured of abundance forever.

With the recognition of man's moral obligation to Mother Earth, each nation must assume the responsibility of taking over the reclamation of heritages wasted by unfaithful stewards over lands that have become sterile stones, riddled with wasting gullies, and by intelligent land use bring them back to productivity as much as possible. When its resources are fully husbanded in the advanced knowledge of full conservation, the possibilities of the earth for increased populations are far beyond the imagination of mankind in general. If the vast energies of the human race could be directed toward a goal of conservation instead of destruction and despoilation, the good earth would respond with abundance of food for all.

Only by conservation in the fullest sense, of the basic resources of land, water, and the spirit of peoples, can we maintain the human values of wholesome standards of living, opportunity, freedom, justice, and faith in the destiny of our modern civilization. Only in conservation have we the assurance of continued progress in the search for that something which has led humanity out of the stone age to a modern industrial age of development. Only by conservation can we be led on to a higher spiritual and physical development which will express itself in stewardship of the earth for the well-being of humanity for all time.

Fossil Starfish

J. WYATT DURHAM

Two specimens of Astropecten sp., upper surfaces in replica. The animals were buried in mud which eventually hardened into rock and was raised, ages later, to the point above sea level where the fossils were found. These were actually casts of the original starfish whose organic substance and calcareous tests or "skeletons" were dissolved out by percolating ground waters; leaving a perfect negative mold. Into this natural mold the paleontologists poured liquid latex which hardened to form the replica, here shown, of starfish which died millions of years ago. Enlarged approximately 3½ times. (Photograph by Toshio Asaeda)

On April 19, 1947, a group of some thirty geology students from the California Institute of Technology, led by Dr. J. P. Buwalda, stopped at a roadcut to examine an exposure of Cretaceous shales. The main group of students clustered around the largest exposures, examining the sediments and looking for fossils. One of the group, Wayne A. Roberts, delayed in getting out of his car, observing that the rest of the group were not finding any fossils, and moved down to a smaller cut close by. As the other students called to him to leave, his eye caught a darker area on a bedding

plane different from the surrounding rocks. Hurriedly breaking that part of the outcrop off, he grabbed it and ran for his car. Later on during the trip he inspected his find and saw that he had fossils—apparently starfish. Thus was made one of the most unique and interesting finds of the fossil record on the Pacific coast.

After the identity of the fossils was confirmed in the laboratory, Roberts made a second trip to the point of his original discovery and collected all the additional specimens he could find. In all, material representing at least thirty-five individuals of a single new species of *Astropecten* and one individual of the genus *Henricea* (?) were found over an area of about one square foot on a single bedding plane.

All the adjacent accessible areas of the same bedding plane were carefully searched, as were the adjoining strata, but no traces were found of more starfishes or even of other fossils. The only other evidences of life were some trails and tracks on the same bedding plane, probably representing the passage of various crustaceans or other invertebrates, and fragments of land plants. It appears probable that a colony of starfish was living in shallow water, possibly along the front of a delta, and was suddenly buried by a flood of sediment carried out by the river. If the starfish had not been buried suddenly, the tests would have disintegrated upon the death of the animals and would not have been preserved as fossils.

The locality of Roberts' find is a roadcut along the highway from Ojai to the Cuyama Valley, California, about 6.3 miles northeast of Wheeler Springs, in dark greenish black, silty shales of the Chico group.

The uniqueness of Roberts' discovery is testified to by the fact that in all the multitude of paleontologic papers on the North American Mesozoic and Cenozoic, there are only twenty references to fossil starfish of the Class Asteroidea, while most other groups of fossils are represented by hundreds of citations. Seven of these twenty records refer only to the occurrence of isolated plates that were not described. Of the remainder, only two species occur in numbers comparable to the present find.

One of these species, *Austinaster mc-carteri* Adkins, represents a new genus not found living, nor has it been recorded elsewhere than from its type locality, yet the type material, a slab of the Austin chalk, of Cretaceous age, has only twenty-five individuals visible on the surface and many more beneath the surface. It was found on a branch of Bouldin Creek, Travis County, Texas, and was described in 1928.

The other species, which presumably occurred in comparable numbers, is represented in the University of California Paleontologic Collections by only two specimens, and is not known to be in any other collections. It is *Asterias remondii*, described in 1864 by Gabb in *Paleontology of California*. He records that it is "found abundantly at Star Fish Point on the Pinole Ranch, south of the Straits of Carquinez," and notes that he compared many specimens in describing it, yet today it is known only by the two specimens, and the locality has never been rediscovered.

Besides *Asterias remondii*, the only other Pacific coast record is an undescribed species noted by Whiteaves from the Cretaceous strata of Nanaimo, British Columbia.

NOTE. The scientific description of these starfish, by J. Wyatt Durham and Wayne A. Roberts, will appear in the *Journal of Paleontology* for July 1948.

Tallest of all trees—many are 350 feet high—some are 2,000 years old.

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CAUSES OF CATASTROPHE. By L. Don Leet. Whittlesey House–McGraw-Hill Book Company, Inc. New York and London. 1948. vii + 232 pp. 10 photographs. 70 line drawings, charts, and maps. $3.00.

This is a book about earthquakes volcanoes, tidal waves, and hurricanes. It would be hard for such a book to be dull, and this one definitely is not. The author writes easily, interestingly and, on three of his major topics, clearly and informatively.

The chapter on "Tidal Waves" is least successful, being cluttered with a discussion of ocean tides and of world-wide changes of sea level. Neither of these topics is especially relevant to that of catastrophic "tidal" waves (tsunamis), which are of seismic origin, and neither of them is treated in a manner that will adequately inform the reader. For example, *spring* and *neap* tides are explained, correctly, in one sentence (p. 176) and diurnal inequality of the tides, a little less accurately, in two sentences. These are masterpieces of condensation, but the meaning is clear only to persons who already know the explanations. There are other criticisms that might be made of the author's discussion of tides, which, however, would carry us beyond the scope of a book review.

The treatment of tsunamis (which is what the Japanese call "tidal" or, more correctly, seismic sea waves –and they should have a word for them!) is informative, and goes into some detail regarding the Pacific tsunami of April 1, 1946, which originated from a submarine earthquake in the Aleutian area and reached Honolulu in four hours and thirty-four minutes, traveling at an average speed of 490 miles per hour.

The use of the word "seiches" at the bottom of page 179 to describe the effects of tsunamis in bays and inlets is somewhat confusing, as is likewise the statement at the top of the following page, "The tsunami (Leet does not pluralize the word with an *s* as do other authors) travel across the open ocean with a velocity often close to that of true tidal waves, from 300 to 500 miles per hour." The word "seiche" has a much broader meaning than is made clear to the reader; and anyone who has studiously read the author's explanation of ocean tides will have gained the impression, rightly or wrongly, that "true tidal waves" move with about the velocity of the earth's rotation–say 1,000 miles an hour at the equator.

Two-thirds of the book is devoted to earthquakes, volcanoes, and mountain building, and it is in these chapters that the author, a professor of seismology in Harvard University, is at his best. Mythology, history, superstition, and science, as they relate to movements of or changes in the earth's crust, all come under discussion. We learn that "earthquake weather" is a myth, that earthquakes are not accompanied by flashes of fire, that there are no authentic records of chasms opening up and swallowing persons or animals with the possible but doubtful exception of one cow. On the other hand, we learn that the earth's crust is far from stable, and that a single seismic disturbance may apply "a blow of greater energy than could be produced by the sum total of all explosions made by man since history began."

The chapter on "Mountain Making and Volcanoes in the Pacific" is of special interest to readers of *Pacific Discovery*.

The book is well written, well illustrated with diagrams, photographs, and maps, and all in all brings together a large amount of information that it would take the reader a long time to find anywhere else. *Causes of Catastrophe* is one of the Science-for-the-Layman Series, chosen for honorable mention in the Whittlesey House–*Science Illustrated* $10,000 Fellowship Contest.

There appears to be a curious mechanical error in page make-up, which can hardly be charged to the author: A paragraph on page 42 ends with the words, "Some examples:". What follows is the heading and body of another section. The "examples" are neatly tabulated on page 41.

ROBERT C. MILLER
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HAWAIIAN AMERICANS. By Edwin G. Burrows. Yale University Press. 1947. 228 pp. $3.00.

An undetermined number of centuries ago some Polynesians reached what later came to be called the Hawaiian Islands and established a well ordered primitive society. Beginning in the eighteenth century Caucasians from the western world, traders, fishermen, missionaries, and industrialists, went out to the same Islands and made their homes there. After the sugar industry had been developed, a great need for labor appeared which was met by the importation of people from China and Japan. Thus four different cultural groups were brought to live side by side with each other, to get along with and adjust to each other as the forces within each group might determine.

Edwin Burrows sketches, most briefly, this oft told tale for the purpose of bringing out the answer to the question he asks. And the question is most significant, for quite obviously four different cultures cannot mingle for nearly a century without in some way affecting each other. The Caucasian group rose to a position of dominance in the life of the Islands, primarily because of their technological and social advancement. The Hawaiians copied some of the Caucasian ways, but being quite unable or unwilling to fit

into the Caucasian pattern, were relegated to the sidelines of society, coming to rest in some of the minor economic enterprises and in political life. The original Oriental immigrants retained the cultures they brought from their homelands, but their descendants rapidly acquired the patterns of western life, and gradually began to find places for themselves in those patterns.

Hawaiian Americans traces these developments and illustrates how they have occurred with numerous incidents from Island life. The book is divided into two parts. The first outlines the growth of Caucasian dominance (the author calls it "prestige") and shows some of the ways in which the other three races have taken over the customs and ways of the Caucasians. The second deals with the problems of mingling races on a deeper level and suggests three different reactions that the Hawaiian, Chinese, and Japanese have had to Caucasian civilization. The reactions which the author finds are: aggression againts the Caucasians, for which there are only a few examples; withdrawal, a reaction seen mainly among the Hawaiians; and coöperation, which is demonstrated in many illustrations, among them being the record of Japanese-Americans in the last war. The author concludes that Caucasian prestige (and here he means western civilization) has been established among the Hawaiians and the Hawaiian-born children of Oriental immigrants. He says, "the superiority in technology of Caucasian culture is enough to ensure the prestige of heirs to that culture." And at the close of the book there are some general principles laid down for the guidance of nations who have come into control of alien populations.

The book is an all too brief study of the process of acculturation as it has taken place in the Hawaiian Islands. It moves along lines to which attention must be given if people are to understand the problems involved in the mingling of races and cultures. But the evidence presented is far too superficial to result in anything more than the pointing of the direction in which other similar studies must go. That, however, is important enough to warrant a careful perusal of the book.

Two points are deserving of comment. One, the book deals with Caucasian life over a period of more than one hundred years with practically no indication that any fundamental change has occurred in it during that time; yet the courageous, creative western spirit which with firm faith in its own powers carved out huge plantations from semi-tropical lands and overcame almost insuperable obstacles in doing so, now show signs of confusion and hesitancy. Second, culture has deep roots within man; it is far more than "customs, language, arts, crafts . . ." although these are expressions of it; for it is linked with the whole of human personality. In light of this the mingling of cultures involves far more than the author suggests. The book by Abram Kardiner dealing with the relation between culture and personality explores this deeper issue in a fundamental way. These may be strictures against Burrows' work, but it is fair to say that he has written about a process which is not yet over and that therefore he has explored only in a tentative way developments still going on. Finally, one strange little error crept into the book. The Makiki Christian Church, housing a Japanese congregation, is spoken of as "a pagoda-like tower," which is an interesting confusion of two Oriental cultures. Actually the church building referred to is in the form of a samurai castle because it was from just such a castle that Christianity first spread in Japan during the middle of the sixteenth century.

J. Leslie Dunstan

Hawaiian Board of Missions
Honolulu

PACIFIC CREST TRAILS. By Joseph T. Hazard. Superior Publishing Company, Seattle, 1946. 317 pp. 17 photographs. $3.00.

In this book, Mr. Hazard takes as a nucleus the 1,000 miles of well-established mountain trails in the Cascades and the Sierra Nevada and adds 9,000 miles of highways and skyways stretching northward into Alaska and southward through Central and South America to complete what he describes as a Pan-American Pacific Crest Trail. The title is provocative and the jacket design adds to the lure, causing the reader to expect a comprehensive coverage of this far reaching system of ranges with its alpine snow and ice and bristling pinnacles. Of course no book of 317 pages could do justice to such an assignment.

The author handles the problem by concentrating intimately on the Cascades, where he is thoroughly at home, and only touching the high spots in the other mountains. He starts his trail at Katmai and gives us thrilling accounts of the first ascents of the major Alaskan peaks. Then he bypasses the Canadian Coast Range with its baffling Tiedemanns, Waddington, and the rest, in favor of the more frequently described Mt. Robson and the Selkirks.

Back into the Cascades, he writes authoritatively, and leads us with characteristic enthusiasm on personally conducted tours through the lush forests and over the glacial fields surrounding Mts. Baker, Rainier, St. Helens, Adams, Hood, and Glacier Peak. He also takes us for interesting trips to Lake Chelan and Garibaldi Park, above Vancouver. All of these accounts are interspersed with an endless supply of local anecdotes and personal reminiscences as well as the historical background of each area. In Californians, accustomed to our gray, rock-bound successions of jagged crests, his vivid descriptions of 360-degree

panoramas of rolling terrain covered with evergreen forests and studded with towering cones of shimmering white instill envy and the desire to desert our beloved Sierra for at least one vacation in the Cascades. One regrets that Mr. Hazard has never visited the Sierra Nevada and given us the benefit of his enthusiasm and descriptive ability.

We also hope that he will visit California before the next edition of his book goes to press or that he will have some local mountaineer check his data. For instance, he limits the Douglas fir to Oregon, Washington, and lower Canada. If he means *Pseudotsuga taxifolia*, then he will find it growing all through California as far south as Lower California, and as far east as Colorado. He also mentions yellow heather. If he is describing the blooms, then we would give our eye teeth for a specimen. Next, in our campaign for accuracy in the use of the name Sierra Nevada, we would like to explain that Sierra means range and that it is incorrect to use Sierras, Sierra Nevadas, or Sierra Nevada Range. I surmise that when he called the Sierra Nevada the Sierra Madre, it was a casual slip.

Among mountaineering inaccuracies, we note that Mt. Tyndall is cited as the first 14,000-foot peak in the United States to be conquered. Actually, Pike's Peak (14,108 feet) was first climbed in 1819, or 45 years before Clarence King made his heroic first ascent of Tyndall. Also Mt. Robson was climbed only two years after Hazard's attempt in 1926, and not seven years later. The successful climbers were Hans and Heine Fuhrer, Norman Clyde, Don Woods, and a girl, Marian Montgomery. Then too, Mt. Keith is described as rising from Forester Pass on the Kings-Kern Divide, whereas it rises from Junction Pass on the Sierra Crest. Also there seems to be some confusion about South Palisade and Split Mountain. These are not two mountains of the same height, but one and the same mountain. The name South Palisade was changed to Split Mountain over 40 years ago.

Some mistakes can happen in the best-prepared manuscripts. No one has been harmed, so they can be excused. But, on page 56, Mr. Hazard gives credit to the U. S. Forest Service alone, for the maintenance of the Pacific Crest Trail System "as it winds along the heights of the three Pacific Coast States . . . from Canada to Mexico." Unquestionably the Forest Service has done an excellent job of building and maintaining the trails through the national forests, but there are long stretches of this Crest Trail cutting through three national parks in California—Lassen Volcanic, Yosemite, and Sequoia–Kings Canyon, and the National Park Service has likewise done its share of trail construction and maintenance. By the way, "Kings Canyon National Park" and the "Sequoia National Park" (p. 212) were—after publication of this book—consolidated into the Sequoia–Kings Canyon National Park under the supervision of Superintendent Evind T. Scoyen. As we read over again this same page 212, we become hyper-critical and we note twenty-one inaccuracies, ranging from questionable suggestions to positive errors. Then we begin to wonder how accurate Mr. Hazard has been in those sections of the mountains with which we are less familiar.

So while we cannot recommend *Pacific Crest Trails* as an authoritative reference work, we do commend it highly to the arm-chair mountaineer as good light reading.

OLIVER KEHRLEIN

Sierra Club, San Francisco

WING-TIPS; *The Identification of Birds in Flight*. By Roland Green. Adam and Charles Black, London. 1947. 64 pp. 56 drawings by the author. $1.75.

To the professional ornithologist who is frequently asked for the name of a book that will explain the principles and mechanism of bird flight Roland Green's work will fill a gap. The author begins with a simple account of the skeletal structure and feather arrangement of birds in general as a basis for understanding their aërial movements.

The subtitle, *The Identification of Birds in Flight*, is perhaps misleading if one expects to use this book as a field guide for the identification of species. It will, however, enable the beginner to interpret the significance of different avian movements and to recognize certain groups of birds on the basis of these movements. More attention is given to the various types of flight, such as gliding, soaring, hovering, and movements involved in rising and landing.

Special emphasis has been placed upon waterfowl, waders, and birds of prey, with fewer references to passerine forms. The numerous illustrations included, for the most part, not only do credit to the author's capability as an artist but also to his ability to observe and interpret the swift action of many kinds of birds on the wing.

While designed primarily for English students, so few references are made to specific European species that *Wing-tips* will prove almost equally useful to the American amateur who is seeking a simple explanation of the various types of avian flight.

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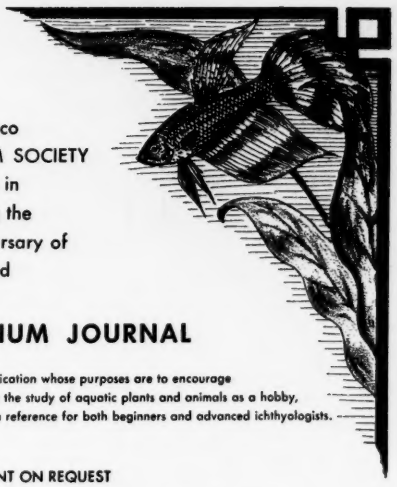

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